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A REPORT ON A COLLECTION OF ENCYRTIDAE WITH DESCRIPTIONS OF NEW GENERA AND SPECIES

BY

HAROLD COMPERE

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A REPORT ON A COLLECTION OF ENCYRTIDAE WITH DESCRIPTIONS OF NEW GENERA AND SPECIES

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INTRODUCTION

THE GREATER number of the species reported upon in this paper were collected by John D. Maple to provide material for a study on the eggs and first instar larvae of the Encyrtidae. The results of this study were reported in a thesis entitled "The Eggs and First Instar Larvae of Encyrtidae and Their Morphological Adaptations for Respiration." Before it is published, however, names are required for undescribed species, and there is need to reclassify some of the described species in order to express certain relationships more closely. It is necessary to express the relationships in the classification of the adults because Maple segregated the eggs into groups on the basis of uniformity in structure, and then attempted to show a correlation between these groups of eggs and groups of closely related species. Unfortunately, the classification of the Encyrtidae is largely artificial, and the species and genera are not generally segregated into groups based on uniformity in the structural features of the adult insects. Taxonomists may aspire to prepare classifications that reflect natural relationships or evolutionary history, but so far as the Encyrtidae are concerned, scarcely a first step has been taken in segregating the species and genera into groups reflecting phylogenetic relationships.

The material that forms the basis of Maple's paper was assembled between 1933 and 1938, while he was a graduate student at the University of California. Only a small number of the species collected by Maple in southern California are referred to in the present paper. The majority of the species are represented by numerous well-preserved, carefully labeled specimens. This collection was given to the University of California Citrus Experiment Station by Maple in 1940. In 1945, John D. Maple was killed in Okinawa, while serving as a lieutenant in the U.S. Naval Reserve.

Types of the species described as new in the paper presented here are to be deposited in the United States National Museum, Washington, D.C.

THE GENERA APHYCUS MAYR AND METAPHYCUS MERCET

HISTORY AND THE TRANSFER OF SPECIES

In 1921, R. G. Mercet proposed *Metaphycus* as a subgenus to designate a group of species very closely allied to *Aphycus punctipes* (Dalman). In 1925, the same author elevated *Metaphycus* to generic rank and designated *Aphycus* (*Metaphycus*) *zebratus* Mercet as the genotype.

The concept of *Aphycus* was greatly modified as a result of Mercet's work. The greater number of species now remaining in this genus need to be reëxamined and transferred either to *Metaphycus* Mercet or to *Euaphycus* Mercet.

Another result of Mercet's work is the need to clarify the status of the two species *fumipennis* Timberlake and *clauseni* Timberlake, originally placed incorrectly in *Pseudococcobius* by their author. The genus *Pseudococcobius* Timberlake automatically became a synonym of *Aphycus* Mayr when Mercet discovered that *Aphycus terryi* Fullaway, the genotype of *Pseudococcobius*, was very closely related to *apicalis* (Dalman), the genotype of *Aphycus*. Timberlake (1916) erected the genus *Pseudococcobius* for three species, namely, *ehrhorni* and *bifasciatus*, described as new, and an older species described as *Aphycus terryi* Fullaway. Later (1918), he described the species *fumipennis* and *clauseni* and placed them in *Pseudococcobius*. In the latter paper he removed *ehrhorni* from *Pseudococcobius* and made it the type of his new genus *Cirrhencyrtus*. It is now clearly evident that *fumipennis* and *clauseni* should never have been placed in the same genus with *terryi*, *ehrhorni*, and *bifasciatus*.

The disposal of *fumipennis* and *clauseni* presents an alternative. These two species can be transferred to *Metaphycus*, to which they are most closely related, or to a new genus erected for their reception. The latter course is regarded as preferable, since these two species are representative of a group of mealybug-inhabiting species, which in habitus appear unlike the typical species of *Metaphycus* that attack soft-scale insects. It seems unfortunate that the genus *Pseudococcobius* was invalidated, for the name had become so well known as to provide a valuable verbal clue to the identity of the mealybug-inhabiting forms. In fact the name *Pseudococcobius* has survived in an informal way, in conversation, ever since it was invalidated. In the present paper the genus *Melanaphycus* is erected for the reception of two species of the invalidated genus *Pseudococcobius*.

Structural Characters and the Basis for a New Genus

It seems desirable to discuss in some detail the status of the genera *Aphycus* Mayr and *Metaphycus* Mercet. The statements made in these pages regarding the structural characters of these two genera are based on the supposition that *Aphycus terryi* Fullaway is fundamentally similar to *A. apicalis* (Dalman), the genotype of *Aphycus*, as reported by Mercet. This is a necessary supposition because of the lack of specimens of *apicalis* for study. It can be taken for granted that the specimens of *terryi*, both those which Mercet studied and those in the collection at the Citrus Experiment Station, were identified correctly, since both lots of specimens were collected in Hawaii and identified by Timberlake. It can also be taken for granted that the specimens of *Aphycus apicalis* which Mercet studied were identified correctly, since these were in the Vienna Museum and had been identified previously by both Förster and Mayr.

The genotype of *Metaphycus*, namely, *zebratus* (Mercet), is represented in the material at hand by one female. This specimen was collected in Spain and identified by Mercet. It is glued to a point in such a way as to conceal the ovipositor and the greater part of the venter of the abdomen. It is assumed

that the concealed characters are not fundamentally unlike those of any one of the numerous other species of *Metaphycus* which are represented by large numbers of well-prepared specimens. In case of an error, *Metaphycus lounsburyi* (Howard) may be regarded as a species for reference concerning the characters of the ovipositor and that part of the abdomen which is concealed in the sample of *zebratus*.

A diagnostic character that is now regarded as very important in classifying the Encyrtidae is the extent to which the ovipositor is enclosed by the sterna. This character was once used by Timberlake and then later rejected by him as unreliable. In the original description of *Pseudococcobius*, prepared before *fumipennis* and *clauseni* were placed in this genus, he (1916) described the sterna as enclosing the ovipositor to the apex of the abdomen. In the later paper (1918), however, in which *fumipennis* and *clauseni* were described under *Pseudococcobius*, he wrote: "The abdominal character used in my recent paper on *Aphycus* to separate the two groups proves to be unreliable, as I have discovered since that the fifth sternite often reaches to the apex of the abdomen even in Aphycus. . . ."[1]

This difference in the extent to which the ovipositor is enclosed by the sterna is correlated with differences in the structural parts of the ovipositor, with a difference in the manner of oviposition and, to a great degree, with a difference in the type of insect attacked. In the species which have the ovipositor enclosed, the act of oviposition is accomplished by an extrusion, or an actual eversion, of the ovipositor. In the species which have the ovipositor partly exposed, only the shaft is exserted during the act of oviposition, the other components of the ovipositor remaining in the concealed position. The species belonging to the first category generally attack soft-bodied insects such as mealybugs, whereas those belonging to the second category generally attack insects having a tough or hardened integument. There are some exceptions, however, and it is because of these that it is difficult to classify the species into sharply defined groups. Too much stress cannot be placed upon the importance of the characters of the abdomen and ovipositor in the classification of the Encyrtidae, for to a great degree the characters found here provide a means for classifying the species into major groups reflecting natural relationships. This fact was appreciated by some of the pioneer workers, and Ashmead (1900) based his tribes, in part, on certain peculiarities of the abdomen and ovipositor.

The following are the more apparent of the structural characters of the abdomen and ovipositor serving to distinguish *Aphycus* and *Metaphycus*:

Ovipositor enclosed by the sterna to the apex of the abdomen. Sternum 7 generally V-shaped. Outer plates of the ovipositor reflected upward at the distal ends so as to overlap the abdomen at apex. Outer plates without broad, platelike apodemes. Ovipositor sheaths long and narrow, movable apart from the plates which bear them, assuming an upright position when the ovipositor is exserted.[2] . . . . . *Aphycus* Mayr

[1] The so-called "fifth sternite" is actually the ventral sclerite of the seventh segment of the abdomen. In the present paper the name "sternum" is used instead of "sternite" to designate an entire ventral sclerite.

[2] In reality, the so-called "ovipositor sheaths" are modified styli of the ninth abdominal segment, at least so far as the Hymenoptera are concerned; and the so-called "outer plates" are the modified, transplaced remnants of the ninth tergum. In the illustrations these are designated as the "gonostyli" and the "gonotergites," respectively.

Ovipositor not enclosed by the sterna to the apex of the abdomen. Sternum 7 transverse, or at least not sharply pointed and V-shaped. Outer plates of ovipositor not reflected upward at distal end; expanded so as to appear as platelike apodemes of blackish color. Ovipositor sheaths generally short and broad, nonerectile, immovably fused to the plates which bear them. . . . . *Metaphycus* Mercet

In Mercet's (1925) characterization of the genus *Aphycus*, the abdomen is described as truncated at the apex. The truncated effect is produced by the reflected ends of the outer plates, which overlap the abdomen at the apex. In

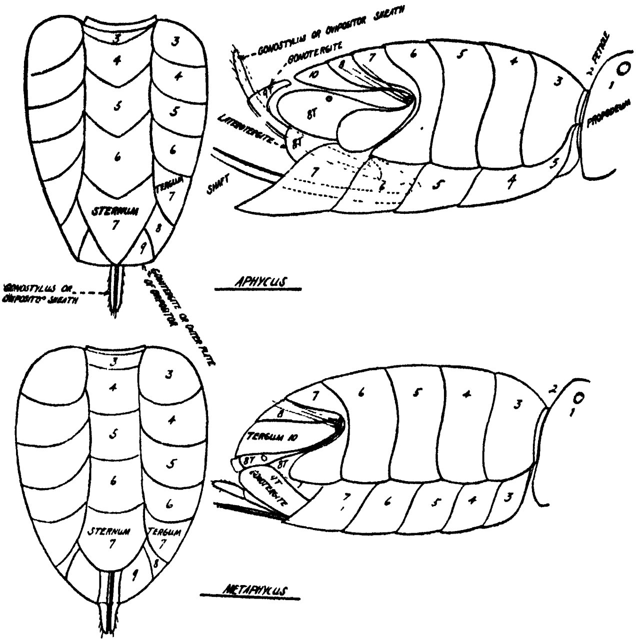

Fig. 1. Ventral and lateral views of abdomen of *Aphycus* (upper; note truncated effect at apex of ventral view) and of *Metaphycus* (lower).

Metaphycus the outer plates are not so reflected upward as to give the abdomen a truncated effect. These differences are shown in figure 1.

In the attempt to discover characters for the separation of the new genus *Melanaphycus* from *Metaphycus*, particular attention was given to the characters of the abdomen and the ovipositor. The individual parts of *Melanaphycus* do not appear essentially different from those of *Metaphycus*. There is a difference, however, for in a number of specimens representing *Melanaphycus*, which were first boiled in potash and then mounted in balsam, the ovipositor assumed a position that is never found in specimens of *Metaphycus* prepared and mounted in the same way. In *Melanaphycus*, the components of the ovipositor other than the shaft partly extrude; but, as previously stated, in *Metaphycus* only the shaft extrudes, or is extrusile by manipulation, and it is impossible to extrude the plates without injuring the specimen. It is suspected that *Melanaphycus* represents a link between the Ectromini and the Mirini.

A better knowledge of how the ovipositor functions, or a better understanding of the structural parts, may reveal differences between *Metaphycus* and *Melanaphycus* which cannot be described now. *Melanaphycus* is referred to the tribe Mirini.

Genus **Melanaphycus** n. gen.

This genus is erected primarily for the two species *fumipennis* Timberlake and *clauseni* Timberlake. A third species, which is identified on the basis of the descriptions as Howard's species *fuscipennis*, is doubtfully assigned to *Melanaphycus*. This species approaches typical *Metaphycus* even more closely than do *fumipennis* and *clauseni*. It was reared from a lecanine scale and not from a mealybug, suggesting that it may be out of place in *Melanaphycus*.

The species of *Melanaphycus* are distinguished by a difference in habitus produced largely by the following characters: extensive black coloration, with or without white maculations; rather distinctive wings, very closely and coarsely ciliated, integumentary infuscations interrupted by hyaline crossbands; and modifications of the integument correlated with color differences. The differences noted here are elaborated upon more fully in the following key, in the descriptions of the species, and in figure 2.

Genotype, *Pseudococcobius fumipennis* Timberlake.

KEY TO THE SPECIES OF MELANAPHYCUS

1. Frontovertex twice as long as wide. Ocelli in an acute triangle.... 2

Frontovertex slightly longer than wide (14:11). Ocelli in an equilateral triangle. Scape at apex white on dorsal margin. Pedicel white on apical half or more
1. *fumipennis* (Timberlake)

2. Head mostly pale lemon yellow to white; oral margin and lower parts of the cheek brown; center of occiput black Scape and pedicel partly white. First three segments of the funicle and the club black. Sides of abdominal terga marked with white
2. *fuscipennis* (Howard)

Cheeks and most of the face below the basal orbital line black. Scape, pedicel, and first five segments of the funicle black; sixth segment of the funicle and the club white. Sides of abdomen completely black except for white encircling the cercal plates
3. *clauseni* (Timberlake)

1. *Melanaphycus fumipennis* (Timberlake)

Pseudococcobius fumipennis Timberlake, Univ. Calif. Publ. Entom., 1:356–358, 1918.

This species has been fully described by Timberlake.

Numerous specimens reared from *Eriococcus* sp., Riverside, California, February and March, 1936. J. D. Maple, collector. Maple's No. 410.

2. *Melanaphycus fuscipennis* (Howard)

Aphycus fuscipennis Howard, Proc. U.S. Nat. Mus., 21:240–241, 1898. Timberlake, Proc. U.S. Nat. Mus., 50: 597–598, 1916.

This species is doubtfully referred to *Melanaphycus*. The following description was prepared some years ago in the belief that the species was undescribed.

Female.—Frontovertex pale lemon yellow; face and cheeks largely white; the oral margin narrowly, and the lower portion of cheeks brown; center of occiput blackish. Club and first three funicle segments black, distal three funicle segments white; base of pedicel black,

apical portion white; outer aspect of scape white with a narrow, longitudinal blackish band across the middle; inner aspect of scape black except broadly along dorsal margin and at apex. Mesoscutum, axillae, and scutellum black, the lateral margins of the scutellum narrowly yellowish; concealed part of pronotum blackish; collar of pronotum white with a blackish spot on either corner; propodeum largely black, with sides adjacent to spiracles white. Sides and venter of thorax largely white. Dorsum of abdomen black, except the lateral margins posterior to the cercal plates; venter of abdomen white to pale brown. Legs dominantly white, with brown spots and bands; all tibiae with two distinct, broad, inter-

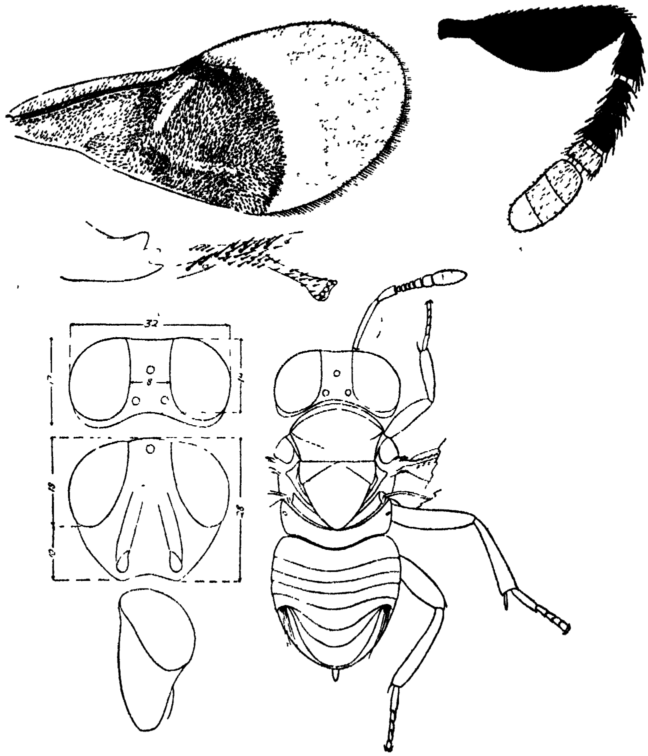

Fig. 2. *Melanaphycus clauseni* (Timberlake). Female.

rupted bands, one slightly distad of the middle and the other midway between the middle and base; all femora with brownish markings forming an intricate, irregular pattern.

Frontovertex finely punctate-reticulate, slightly more than twice as long as wide (11:5), with exceedingly fine white hairs. Ocelli in an acute triangle; posterior ocelli about one-half their own diameter from the orbits and more than once their own diameter from the occipital margin. Scape expanded, twice as long as wide; pedicel twice as long as wide; all funicle segments short and transverse, increasing in size distad, the sixth about twice as wide as long; club large, twice as long as wide and almost as long as the five preceding funicle segments. Eyes very finely and densely hairy. Parapsidal sutures well developed but not meeting. Scutellum large, as long as wide, and plainly longer than the mesoscutum (11:9). Abdomen, after shrinkage, much shorter than the thorax and plainly wider, broadly rounded at apex; ovipositor concealed. Forewings with one white crossband across the blade distad of the stigmal vein; speculum narrow, descending slightly more than one-half way across the blade; the hairs on the blade distad of the white crossband about as coarse and dense as those basad of the band.

Described from 2 females reared from a *Lecanium* sp., Deep Creek, Mojave Desert, May, 1937. J. D. Maple, collector. Maple's No. 39.

3. *Melanaphycus clauseni* (Timberlake)
(Fig. 2)

Pseudococcobius clauseni Timberlake, Univ. Calif. Publ. Entom., 1:358–360, 1918.

The female has not been described. Timberlake's original description was based on a single male specimen reared from an *Erium* sp. on cactus, collected at Riverside, California. In 1936, J. D. Maple reared a large series of specimens from *Eriococcus adenostomae* and an unidentified *Eriococcus*, collected at Riverside, Riverside County, and in Cajon Pass, San Bernardino County, California. These bear Maple's identification No. 420.

Female.—Antennal club and sixth segment of funicle creamy white, remainder of antennae black. Frontovertex, face above the basal ocular line, upper margin of occiput narrowly edged with white, and temples creamy white, or yellow, or variegated brown and yellow. Face and cheeks dominantly black, more or less mottled with yellow or reddish, or brown across the face above the antennal sockets. Thorax and abdomen mostly black; the following parts white: collar and sides of pronotum, mesal halves of tegulae, prepectus, and anterior margins of mesopleura. Legs largely black, marked with well-defined bands of white, as follows: front femora broadly at apical ends; front tibiae at both ends; middle femora narrowly at base and widely at the apical ends; middle tibiae with three bands, one in the middle and one near each end. Basal and apical ends of front and hind tarsi, and apical segment of middle tarsi, black, the remainder yellowish.

Head, thorax, and abdomen with short, flattened white hairs; eyes finely hairy. Mesoscutum, axillae, scutellum, and mesopleura finely punctate-reticulate.

Length 1.2 mm.

Other details as shown in figure 2.

THE BRIGHT-SCARLET SPECIES OF ENCYRTIDAE

Bright-scarlet or red species of Encyrtidae are exceedingly rare, and the few specimens that have been described were regarded as curiosities. Maple, however, reared a large number of bright-scarlet Encyrtidae from coccids collected in southern California. Five different species are represented in the collection. One of these species, which was described as *Aphycus howardii* by Cockerell in 1898, is redescribed in the present paper and transferred to *Metaphycus*. Four of the species are new. A new genus, *Erythaphycus*, is erected for three of the new species; the fourth is described as *Metaphycus flammeus* n. sp.

Three other scarlet or red species of Encyrtidae have been described, namely, *Aphycus sanguinithorax* Girault, from Queensland, Australia; *Dusmetia ceballosi* Mercet, from Spain; and *Xanthoencyrtus sanguineus* Timberlake, from Hawaii. *A. sanguinithorax* is probably very closely related to the species under consideration here, which belong to the tribe Mirini. *D. ceballosi* and *X. sanguineus* belong to the tribe Ectromini.

Genus **Erythraphycus** n. gen.
(Figs. 3, 4)

This genus cannot be defined absolutely. It is most closely related to *Melan-aphycus* n. gen. and *Metaphycus* Mercet. The following are some of the mos striking differences between *Erythraphycus* n. gen. and *Metaphycus* Mercet, as exhibited in the genotypes.

Genus *Erythraphycus*	Genus *Metaphycus*
General color bright scarlet, including the greater part of the legs and part of the antennae. Head, notum of thorax, and abdomen covered with short, squamous, silvery hairs.	General color yellowish to white, with an extensive pattern of dark-brown to black markings.
Thorax unusually short, the mesopleura scarcely longer than wide, punctate-reticulate.	Thorax moderately short, the mesopleura plainly longer than wide, striate-reticulate.
Head strongly transverse and slightly longer vertically than in *Metaphycus*; cheeks about as long as the transverse diameter of the eyes. Frontovertex exceedingly finely reticulated, appearing velvety, as seen in tag-mounted specimens; covered with numerous coarse, short, white hairs.	Head not so transverse and shorter vertically than in *Erythraphycus*; cheeks shorter than the transverse diameter of the eyes. Frontovertex punctate-reticulate and almost bare.
Forewings covered with densely crowded coarse, blackish hairs, interrupted by two crossbands of whitish hairs. Postmarginal vein, if present, obscured by blackish hairs.	Forewings with normal ciliation and without crossbands of whitish hairs, and very slightly embrowned for the greater part. Postmarginal vein very short but distinguishable, according to Mercet.
Tenth tergum (apical dorsal sclerite) moderately enlarged, in this character suggestive of the Ectromini.	Tenth tergum narrow, strongly crescentric as in typical Mirini.
Antennal scape expanded but not triangularly. First two segments of the funicle disproportionately small, the following segments subequal. (See fig. 3.)	Antennal scape triangularly expanded below. First four segments of the funicle disproportionately small, the following two segments much larger and successively increasing in size.
Scrobes defined by the absence of short, coarse, white hairs; vertical, not meeting above; very slightly impressed.	In the single specimen of *Metaphycus zebratus*, the head is pressed down so as to conceal the face. In *M. lounsburyi* and closely related species, the scrobes form a broad, shallow, semicircular facial impression.

If any structural characters, or group of structural characters, can be singled out as definitely separating *Erythraphycus* from *Metaphycus*, these are probably to be found in differences in the conformation of the abdomen and in the ovipositor. These characters are concealed in the single specimen of *Metaphycus zebratus*, which is mounted on a tag. In other species of *Metaphycus*, such as *M. lounsburyi* (How.), which is regarded as a typical representative of this genus, the components of the ovipositor that have evolved from the ninth tergum, and that appear as a pair of plates to which the first valvifers articulate, are widely expanded and strongly melanized, and the tenth tergum is narrow. In *Erythraphycus*, as represented by the genotype, the corresponding elements of the ovipositor are narrow, nonmelanic, and inconspicuous, and the tenth tergum is enlarged. In figure 3 the abdominal terga of *Erythraphycus argyrocomus* n. sp. are shown flattened out so as to reveal the shape and proportions of the sclerites, including those associated with the ovipositor; the corresponding elements of *Metaphycus lounsburyi* (Howard) are also shown for comparison.

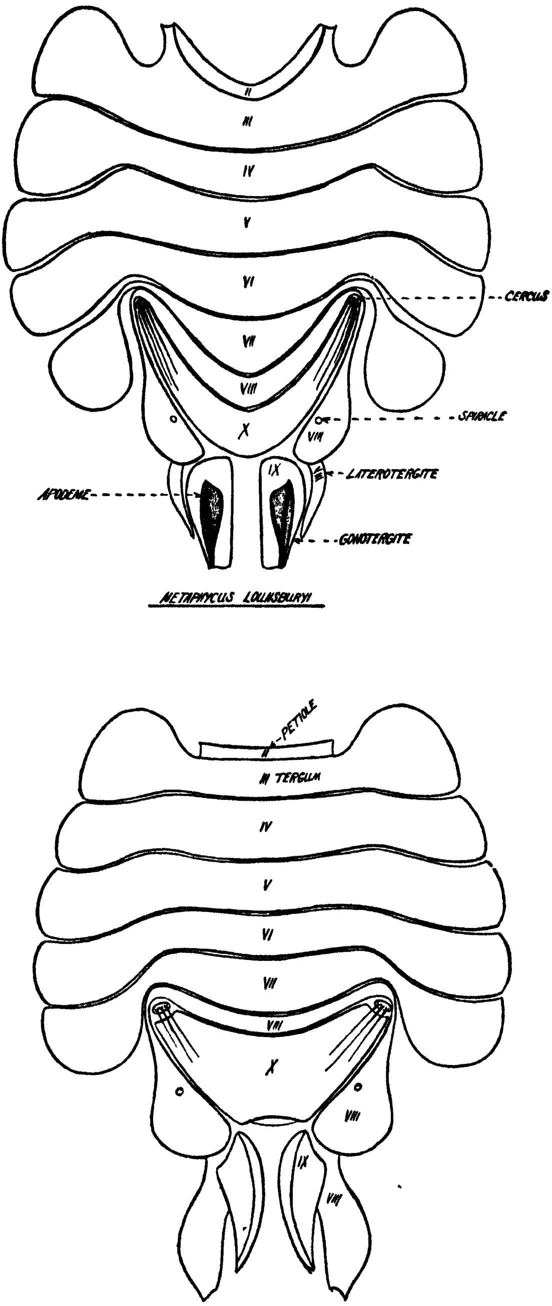

Fig. 3. Terga of abdomen and parts of ovipositor derived from the eighth and ninth terga, shown in flattened form. Above, *Metaphycus lounsburyi* (Howard). Below, *Erythraphycus argyrocomus* n. sp. Females.

Additional characters for the recognition of *Erythraphycus* follow: Mandibles with three nearly equal teeth. Maxillary palpus four-segmented; labial palpus three-segmented. Antennae of characteristic form inserted close to the oral margin, as shown in figure 4. Face, cheeks, and frontovertex with an exceedingly fine sculpture giving a velvety effect, and the entire area clothed with short, thickened, silvery hairs similar to those on the notum of thorax and abdomen. Thorax not much longer than wide (11:10), rectangular, and almost as wide at the pronotum as at the propodeum.

Genotype, *Erythraphycus argyrocomus* n. sp.

KEY TO THE SPECIES OF ERYTHRAPHYCUS[3]

1. Legs banded with brown 2
   Legs largely scarlet, not banded, the tarsi yellow or whitish . . 1. *argyrocomus* n. sp.
2. Club of antennae white. Head scarlet, covered with small, squamous, silvery hairs . . . 2. *matteolus* n. sp.
   Club of antennae black. Head pink above, finely punctate, with very fine scarcely perceptible hairs; face transversely banded with white . . . . 3. *calvus* n. sp.

1. **Erythraphycus argyrocomus** n. sp.

(Figs. 3, 4)

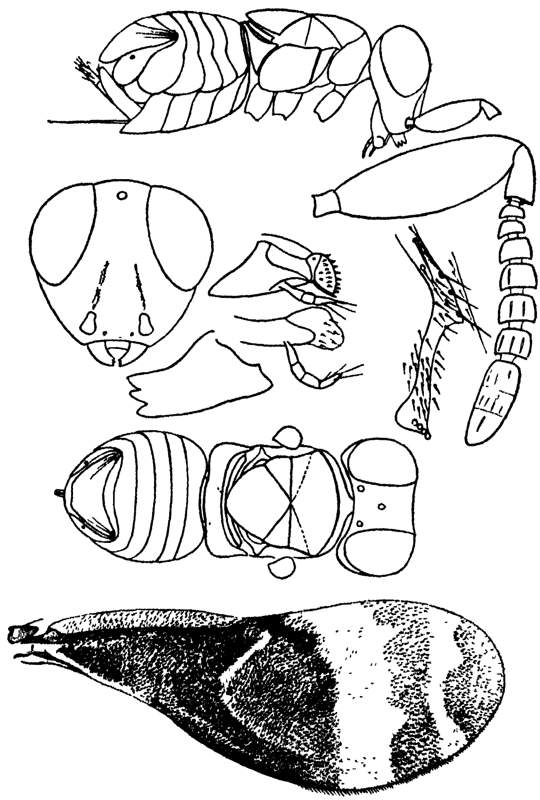

Fig. 4. *Erythraphycus argyrocomus* n. sp. Female.

[3] It is to be noted here that *Erythraphycus matteolus* n. sp. is known from the male sex only. It is placed in the key on the assumption that the males and females will prove to be sufficiently similar to make the identification of the female possible.

This species has been rather fully characterized in the generic description, supplemented by the figures, and in the key to the species. About all that can be added is that in both sexes the segments of the funicle and the club are white and furnished with fine white hairs; the tarsi and tegulae are white; the mesopleura is slightly yellowish.

Described from 50 specimens selected from a lot numbering several hundred, reared from *Eriococcus* sp. taken on croton, asters, and *Ericameria*, in Riverside County, by J. D. Maple, in 1936 and 1937. Maple's No. 400.

2. **Erythraphycus matteolus** n. sp.

This species has the legs mottled and banded with brown and white, a characteristic which readily separates it from *argyrocomus*. Also, the white hairs which clothe the head, thorax, and abdomen are not so distinctly flattened.

Male.—General color bright scarlet, mesoscutum and scutellum with some golden reflections; lateral and ventral parts of thorax grading to yellowish. Scape largely, and the pedicel and first two funicle segments entirely scarlet, remainder of antennae white; distal ventral margin of the scape, from the small emargination to the apex, narrowly blackish. Except for the coxae of the middle and hind legs, which show traces of scarlet, the legs are marked with brown and white, much as in species of *Melanaphycus* and *Metaphycus*; middle tibiae with alternate brown and white bands (five brown and four white bands), the ends tipped with brown bands; front and hind tibiae white. Parapsidal lines complete as in *argyrocomus*.

The head of the specimen is so shrunken that the original shape cannot be determined, but the ocelli are apparently in an equilateral triangle, or nearly so; frontovertex and facial aspect velvety in appearance and covered with fine white hairs. Antennae of about the same general proportions as in *argyrocomus*, except that the scape appears to be relatively larger, and the ventral margin is slightly incised near the apex. So far as can be seen, the front wings are about the same as those in *E. argyrocomus*.

Described from 1 male, holotype, mounted on a tag; one antenna and a wing missing. Captured at La Canada, Los Angeles County, by H. M. Armitage, October 19, 1923.

3. **Erythraphycus calvus** n. sp.

The scarlet color, shape of the antennae, and wing markings indicate the relationship of *calvus* to *Erythraphycus*; in other respects this species does not appear to differ from *Metaphycus*. The most important of the diagnostic characters distinguishing this species are the bare, punctate-reticulate frontovertex; two white bands across the face; one white band across the front wings, and the brown and white markings on the legs.

Female.—Notum of mesothorax scarlet, variegated with golden, and covered with moderately coarse, squamous white hairs; collar of pronotum white with a black dot on either corner; tegulae brown and white; metanotum blackish; prepectus white; mesopleura largely pink, with traces of whitish anteriorly. Head largely pinkish, with two bands of white across the face. Scape with the dorsal margin broadly white, the ventral margin irregularly and broadly blackish, and the sides pinkish or golden with a trace of scarlet; pedicel largely white; first two segments of the funicle brown to black; distal four segments of the funicle white; club black. Femora and tibiae of all legs variegated, or with spots or bands of brown alternating with white markings.

Frontovertex almost twice as long as wide; ocelli in a slightly acute triangle, the posterior ocelli about once their own diameter from the orbits and the occipital margin.

Scape about twice as long as wide, widest towards the apex, in shape more suggestive of

Erythraphycus than *Metaphycus*; pedicel about one and one-half times as long as wide, and as long as the basal two segments of the funicle; segments of the funicle all increase in size distad, and all are wider than long; club oblique at apex and as long as the preceding four segments of the funicle.

Mesoscutum with incomplete parapsidal lines, the inner ends widely separated.

Front wings with one crossband of whitish hairs. Speculum extending about halfway across the blade.

Described from 2 females taken on *Eriogonum* by S. E. Flanders, Riverside, California, October, 1933.

Metaphycus howardi (Cockerell)

Aphycus howardi Cockerell, Canad. Entom. Com., 30:276, 1898. Timberlake, Proc. U.S. Nat. Mus., 50:638, 1916.

Among the species collected by Maple in southern California is a scarlet form which in all respects conforms to Cockerell's description of *Aphycus howardi*; it is identified accordingly.

In the original description of *howardi*, no mention is made of the structural characters. The type which is deposited in the U.S. National Museum is so badly damaged that Timberlake was unable to determine its relationship and was likewise unable to place it in his synoptic table. A redescription of this species follows.

Mandibles with three nearly equal, blunt teeth. Maxillary palpus three-segmented; labial palpus two-segmented. Mesoscutum with exceedingly faint and short parapsidal sutures.[4] Antennae slender; scape not expanded; pedicel about two and one-half times as long as wide, and as long as the first three funicle segments; first four segments of the funicle subequal, each about as long as wide; the fifth and sixth segments much larger than the preceding and about as long as wide; club about as long as the preceding four segments of the funicle and slightly wider than the sixth segment. Frontovertex about twice as long as wide, finely punctate-reticulate, with almost imperceptible, fine, scattered white hairs; ocelli in an acute triangle; occipital margin strongly acute; eyes with microscopic, fine white hairs; abdomen broadly rounded at apex, almost truncate; sheaths of ovipositor extended beyond the apex of the abdomen about the length of a basitarsus of the hind legs. Front wings on the basal half with crowded, coarse hairs; a wide hyaline streak transversely across the blade distad of the venation; apical third or so of the blade with normal, fine hairs.

This is a small, delicate species which shrivels when preserved on a card. In a great many respects it is suggestive of *Euaphycus* Mercet; however, it is distinguished by its color, patterned front wings, exserted ovipositor, and vestigial parapsidal lines.

This species is represented in the collection by 4 females and 4 males; of these, 1 female was reared by P. H. Timberlake from an *Eriococcus* sp. on *Ericameria*, Riverside, January 22, 1926; 1 female and 3 males were reared by J. D. Maple from *Eriococcus* sp., Riverside, August, 1937; 1 female and 1 male were collected by S. E. Flanders, Riverside, California, October 10, 1933; 1 female was collected by Maple but not labeled.

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[4] The so-called "parapsidal sutures" are external lines marking the course of endoskeletal ridges, which arise at the anterior lateral corners of the mesoscutum and extend toward the meson. In some species, especially in the genotype *Metaphycus zebratus* (Mercet), the external lines are blackish and conspicuous. In this species the parapsidal lines converge posteriorly and meet on the meson of the posterior margin of the mesoscutum, and the lateral cut-off pieces of the mesoscutum are about the size and shape of the axillae.

Metaphycus flammeus n. sp.

This species is represented by two males and the detached antennae, trophi, legs, and wings of one female. In Timberlake's key to the species of *Aphycus*, females, the species runs to couplet five, which includes *fuscipennis* Howard and *schwartzi* Timb., but these are quite different in color. In the key to the males this species runs to couplet three, which does not provide for it, since the notum of the mesothorax is nearly "flame scarlet" (Ridgway,1912).

This species is not unusual structurally: its habitus is that of a typical species of *Metaphycus*. A short cut to the identity of this species is provided by the color of the antennae in the female, in which the entire funicle, most of the pedicel, and the dorsal margin of the scape are white, the scape scarlet or reddish laterally and the club black.

Female.—Scape a trifle more than twice as long as wide; pedicel scarcely twice as long as wide, as long as the first three segments of the funicle; funicle segments all wider than long and increasing in size, the fifth and sixth subequal and about twice as wide as long; club oblong, the dorsal and ventral margins almost parallel, and the apical margin almost truncate. Forewings very densely and darkly ciliated, except for a broad crossband of transparent cilia beyond the venation; speculum narrow, and terminating below near the middle of the blade; marginal vein about as wide as long; postmarginal vein not produced; stigmal vein about two and one-half times as long as the marginal vein. Hind legs with the ground color faintly suffused with reddish, in contrast to the pallid white ground color of the front and middle legs. Tibiae of all legs, and the femora of the middle legs, with brown spots more or less arranged in pairs; tarsi white with the distal segments blackish.

Male.—Mesonotum, sides of propodeum, and margins of the abdomen flame scarlet or nearly so. Head largely yellow, with the frontovertex tinged with some scarlet and the face grading to whitish. Club black, preceding funicle segments yellowish white, grading to brown basally; apical half of pedicel and most of scape yellowish, the latter margined with black below, and white above toward the apex. Concealed part of the occiput, pronotum, and a dot on either corner of the collar of the latter, black. Collar of pronotum, and the tegulae, partly white. Prepectus and anterior margin of mesopleura white, the remainder of mesopleura yellowish. In this sex, the spots on the femora are largely coalescent, forming bands, and the ends of the femora are more plainly tipped with blackish than in the female. The slightly reddish tinge noticed in the balsam-mounted hind legs of the female is not apparent in the males.

Frontovertex slightly longer than wide (5:4), finely punctate-reticulate, and almost bare. Ocelli in an equilateral triangle, the posterior pair about once their own diameter from the eye and the occipital margins. Antennae quite similar to those of the female except for the scape, which is less widely expanded.

Notum of thorax clothed with fine white hairs. Mesoscutum with faint but distinct parapsidal lines meeting on meson, anterior to the posterior margin.

Described from remnants of 1 female, as previously noted, and from 2 males, all reared from *Lecanium quercitronis* collected at Claremont, California, May 9, 1939, by J. D. Maple. Maple's identification No. 40. The male mounted in balsam is designated as the holotype, the remnants of the female as the allotype, and the point-mounted male as a paratype.

Genus **Ectromatopsis** n. gen.

(Fig. 5)

This new genus is erected for a single species, *Ectromatopsis americana*, which is thought to be the same as *Ectroma americanum* Howard. If the two are not identical, then the species described and figured here under the name *Ectromatopsis americana* is the genotype, not *Ectroma americanum* Howard.

In the material available for study, *Ectroma* Westwood is represented by two females from Spain, identified by Mercet as *rufum* (Dalman), the genotype. Some of the major differences distinguishing *Ectroma* from *Ectromatopsis* follow.

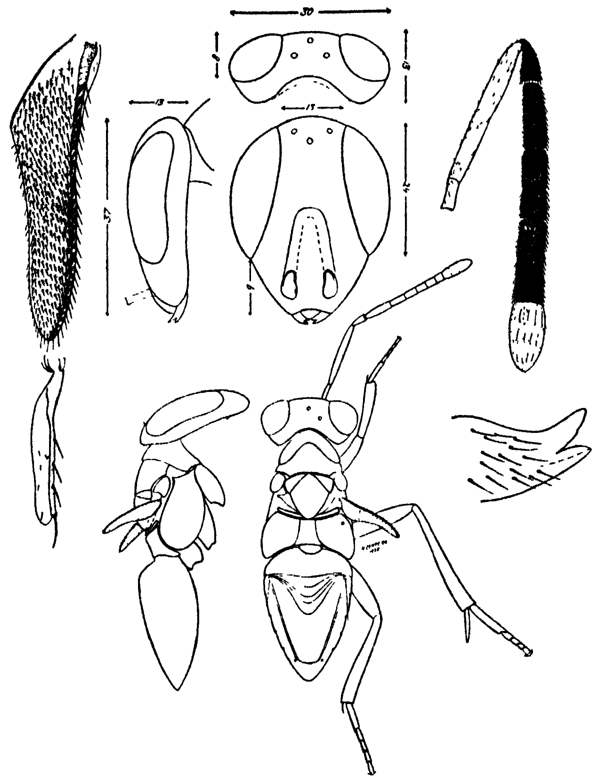

Fig. 5. *Ectromatopsis americana* (Howard) new combination.

Genus *Ectromatopsis*

Head, anterior aspect, longer than wide (37:30); antennal sockets with their upper margins below the basal ocular line; oral margin normal; labrum small, concealed, or inconspicuous; mandibles small; scrobes twice as long as the length of the antennal sockets.

Thorax subpyriform, as seen from above, widest at the propodeum.

Scutellum without a foveate depression at the base, the latter plain; mesoscutum without parapsides. Notum of thorax covered with dense, fine white hairs.

Genus *Ectroma*

Head, anterior aspect, wider than long (30:25); antennal sockets with their lower margins about on, or slightly above, the basal ocular line; oral margin emarginate, that is, epistoma abruptly indented so that a quadrate notch appears in the oral margin; labrum large and conspicuous; mandibles large; scrobes about as long as the antennal sockets.

Thorax subquadrate, not much wider at the propodeum than at the prothorax.

Scutellum foveate at the base, the latter convex; mesoscutum with fine but distinct lines indicative of parapsides. Notum of thorax, head, and abdomen appearing glazed, the sculpture and vestiture exceedingly fine and sparse.

Other diagnostic characters of *Ectromatopsis* which are not mentioned in the comparisons, and which are not evident from figure 5, are the following:

Maxillary palpus four-segmented; labial palpus three-segmented; frontovertex very delicately shagreened, the axillae and scutellum slightly more coarsely sculptured than the head; mesoscutum with exceedingly fine, dense white to yellow hairs, the hairs less dense on the scutellum. Spiracles of propodeum rounded, with raised rims. Propodeum laterad of the carinae, with dense white pubescence.

General color brownish yellow; club of antennae white; the funicle and pedicel more or less black, in some specimens the basal segments of the funicle and the pedicel yellowish. Sides of propodeum, abdomen, and middle and hind coxae, more or less brown or blackish.

The description given here, and figure 5, are based on an extensive series of specimens reared from *Phenacoccus solani* Ferris collected by J. D. Maple at Riverside, California, February 18, 1935.

Genotype, *Ectromatopsis americana*, new combination, supposedly the same as *Ectroma americanum* Howard (Proc. U.S. Nat. Mus., 21:248, 1898).

Howard's description was based on a single female collected by T. D. A. Cockerell at Mesilla, New Mexico, June 24, 1896. Type No. 3852, U.S. National Museum.

GENUS ANAGYRUS AND CLOSELY RELATED GENERA

Anagyrus Howard and the genera closely related to it have the following major diagnostic characters.

Mandibles bidentate. Tenth tergum enormously enlarged so as to cover the greater part of the abdomen. Paratergites well developed, long, and narrow. Ovipositor sheaths slightly if at all differentiated from the plates which bear them. The abdominal characters mentioned here are illustrated in figure 6, the parts being named in conformity with the terminology used in the text.

The following genera are regarded as closely allied to *Anagyrus*: *Paranusia* Brèthes, *Gyranusa* Mercet, *Heterathrellus* Howard, *Pseudleptomastix* Girault, *Leptomastidea* Mercet, *Callipteroma* Motschulsky, *Leptomastix* Förster, and the two new genera *Apoanagyrus* and *Gyranusoidea*.

Philoponectroma Brèthes was described from male specimens only, and is not included in this list of genera. Timberlake (1923) has already pointed out that in his description Brèthes probably erected two genera for one species, namely, *Philoponectroma* for the males, and *Paranusia* for the females. Timberlake noted the peculiar little scalelike hairs standing erect in a row on the sixth segment of the funicle and the basal segment of the club, as shown in Brèthes' figure of the male antennae in *Philoponectroma*. This character was considered peculiar to *Anagyrus* by Timberlake, but since he studied these insects, it has been found that similar scalelike hairs occur in the males of *Pseudleptomastix*, as well as in an anomalous species described previously by me (1938) under the name *Gyranusa citrina*, and in the new species described in these pages as *Apoanagyrus californicus*.

In the collection of the University of California Citrus Experiment Station there is a species reared from mealybugs collected at Bahia, Brazil. This species appears to be congeneric with *Paranusia bifasciata*, with one important exception: in *bifasciata* the postmarginal vein is described and figured as wanting,

whereas in the species from Brazil the postmarginal vein is longer than the stigmal vein. This vein is difficult to distinguish because of the dark integumentary infuscation and dense clothing of hairs. If the postmarginal vein in *bifasciata* is actually long, and not short, as described by Brèthes, the genus *Paranusia* is out of place in the key which follows. I am inclined to consider *Paranusia* Brèthes to be just about as distinct as are the majority of genera closely allied to *Anagyrus*.

Howard's genus *Heterathrellus* is difficult to recognize and place in a key, in the absence of specimens for study. According to Timberlake (1916), *Heterathrellus* will run next to *Anagyrus* in any natural classification. This author also stated that the mandibles are bidentate and not tridentate as described originally. In connection with this genus it is to be noted that the type species, *H. australiensis* Howard, is recorded as issuing from the pupae of coccinellids. So far as is known, with this exception, all the species of *Anagyrus*, and the species of the genera closely related to it, parasitize mealybugs.

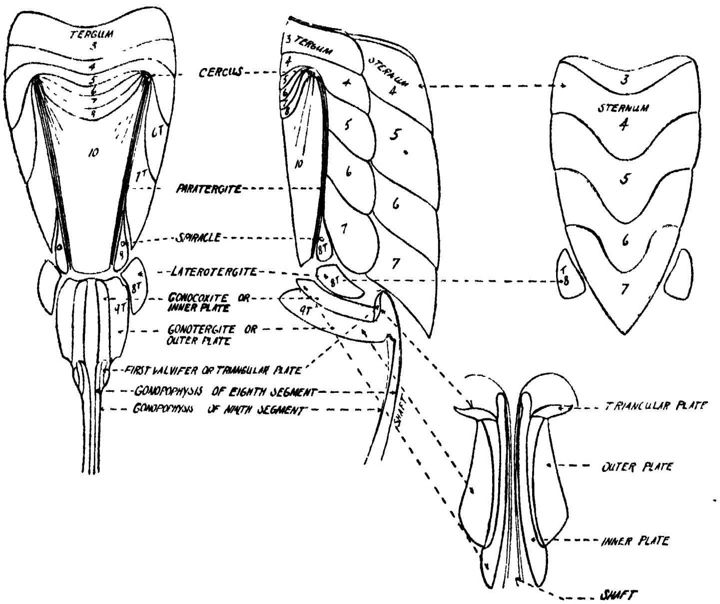

Fig. 6. Abdomen of *Anagyrus*, with parts named.

According to Mercet (1924), his genus *Gyranusa* differs from *Anagyrus* Howard in the following characters: the submarginal vein is nearly contiguous with the costal margin of the wing, thus almost suppressing the costal cell; the marginal, postmarginal, and stigmal veins are of nearly equal length; the front wings are slightly infumated along the anterior and posterior margins. A specimen of *Gyranusa minimum* Mercet, identified by him, is available for study. One difference not mentioned by Mercet is that in *Gyranusa* the antennae are proportionately longer than in *Anagyrus*. In sculpture, vestiture, size, and coloration, *Gyranusa* resembles *Anagyrus*.

In 1938, I described the species *citrina* under *Gyranusa*. This species is incorrectly placed in *Gyranusa*. In the key to *Anagyrus* and related genera, the new genus *Gyranusoidea* is erected for *citrina* and several new species as yet undescribed.

Girault (1915*a*) erected the genus *Pseudleptomastix* for the species *squammulatus*, which he described from two females labeled "State Insectary, California 675," reared from mealybugs taken on grapes at Fresno, California, in 1914, by E. J. Branigan. In the collection at the Citrus Experiment Station are specimens of this same lot of material, but these specimens do not appear to be any different from those reared from *Erium lichtensoides* collected in southern California, which I (1926) described as new under the name of *Pseudleptomastix flatulescens*. *P. flatulescens* is here made a synonym of *P. squammulatus* Girault.

KEY TO ANAGYRUS AND CLOSELY RELATED GENERA

1. Scape not expanded below, or very slightly so. Postmarginal vein generally longer than stigmal vein . .6

   Scape strongly expanded below. Postmarginal vein variable .2

2. Wings without dark crossbands 3

   Wings with dark crossbands Scape rather narrowly expanded, gradually increasing in width toward the apex. Postmarginal vein described as absent. Frontovertex bare (in Brèthes' figure), and the eyes and notum of thorax strongly hairy *Paranusia* Brèthes

3. Costal cell normal, or not greatly reduced in size 4

   Costal cell very narrow and almost, if not actually, suppressed apically. Scape not so widely expanded as in *Anagyrus*, and the antennae longer. Head, thorax, and abdomen with numerous flattened white hairs. Postmarginal, stigmal, and marginal veins subequal. General color orange or yellow, nonmetallic. Wings hyaline or longitudinally infuscated *Gyranusa* Mercet

4. Frontovertex finely punctate, bare or nearly so . 5

   Frontovertex so closely reticulated as to eliminate any punctate effect, and almost always with numerous squamous white hairs. Postmarginal vein usually shorter than the stigmal vein. Scape widely expanded below; first segment of the funicle rarely much longer than the pedicel. Head, thorax, and sides of abdomen usually clothed with squamous white hairs. Nonmetallic; most often orange or yellow with darker markings Wings hyaline. *Anagyrus* Howard

5. Yellow, nonmetallic, small in size. Scape moderately expanded, about as in *Gyranusa*. Face with a slight, inconspicuous, punctate convexity between the scrobes; scrobes separated above. Anterior ocellus almost in the center of the frontovertex. Postmarginal vein plainly longer than the stigmal vein. Male antennae with scalelike erect hairs in a row on apical segment of the funicle, and on basal segment of the club *Gyranusoidea* n. gen.

   Blackish, partly metallic, moderate in size. Scape widely expanded; the antennae about as in *Anagyrus*. Face with a smooth, rounded convexity between the scrobes, about as prominent as that in *Leptomastix*, the scrobes meeting above, almost smooth, and shining. Lower part of face, mesoscutum, collar of pronotum, sides of propodeum, and basal corners of the abdomen with flattened whitish hairs. Marginal, postmarginal, and stigmal veins subequal. Wings hyaline . . *Apoanagyrus* n. gen.

6. Postmarginal vein generally longer than stigmal vein.... 7

Postmarginal and stigmal veins subequal and longer than the marginal vein. General color black, the head and mesopleura orange. Head, thorax, and abdomen opaque. Mesoscutum and cheeks covered with short white hairs. Frontovertex and mesoscutum closely, microscopically punctate. Scape subcylindrical and long, reaching above the top of the head. First segment of the funicle six times as long as wide *Heterathrellus* Howard

7. Antennae and wings unusually long... 8

Antennae and wings of normal length, the former plainly much shorter than the head, thorax, and abdomen. General color black, the tegulae white. .*Pseudleptomastix* Girault

8. Pedicel generally much shorter than the first segment of the funicle........... 9

Pedicel about as long as the first segment of the funicle. Wings hyaline or with dark crossbands. Sides of abdomen bare. Eyes not elongated, and strongly protuberant. Face without a strongly elevated ridge between the antennae. Small species, the heads of which tend partly to fold after drying. Wings held semierect in life *Leptomastidea* Mercet

9. Wings generally infuscated with clear spots, or clear with large, dark crossbands. Sides of abdomen strongly pubescent. Antennae of the males having short hairs uniformly distributed. Wings held erect in life. .. .. *Callipteroma* Motschulsky

Wings most often hyaline, sometimes longitudinally infuscated; in life held in the usual horizontal position. Eyes unusually long and strongly protuberant. Cheeks very short and strongly convergent. Head thin fronto-occipitally. Face with a strongly elevated ridge between the antennae .. . .*Leptomastix* Forster

Genus **Apoanagyrus** n. gen.

The diagnostic characters pertaining to this genus, which have been given in the preceding key and are portrayed in figure 7, constitute the generic description.

Genotype, *Apoanagyrus californicus* Compere.

This genus is represented by a large number of specimens. Because it is uncertain whether these specimens represent more than one species, distinctions have to be made among them, and the specimens selected as types are restricted in number. Provisionally, however, all the specimens representing *Apoanagyrus* are referred to the species *californicus*.

Apoanagyrus californicus n. sp.

(Fig. 7)

The specimens selected as types of this species are distinguished by having the antennal club white, and all the coxae blackish. This lot of specimens was reared from *Phenacoccus solani*, in the insectary at Riverside, by Maple, in 1935. Another lot of specimens, not of the type series, is distinguished by having the club blackish basally, grading to brown or whitish at the apex. Some specimens of this lot were collected at Riverside, by Flanders, in 1933; and others were reared from a *Phenacoccus* sp. (No. 68) collected at Perris, by Maple, in 1936. One female is distinguished by having the front coxae pale straw-colored. This female was reared from a *Phenacoccus* sp. (No. 31) collected at Whittier, by Maple, in 1935.

Female.—General color black, metallic; the axillae and scutellum opaque. In some specimens the sides and underparts of the thorax and abdomen are dark brown. Antennae black and white, with white coloration as follows: scape at apex, with an oblique check mark; apex of pedicel; second and third segments of the funicle; and club, except as already noted. Legs predominantly brownish or straw-colored; the coxae black, except as already noted; femora of middle and hind legs more or less extensively suffused with blackish; front femora suffused with blackish on the basal part only; apical segments of the tarsi blackish.

Head above, and the eyes, furnished with a few exceedingly fine hairs; those on the fronto, vertex arranged in four longitudinal rows, a pair of submedian rows of widely spaced hairs and orbital rows of more closely spaced hairs. Small, squamous, refractive hairs which

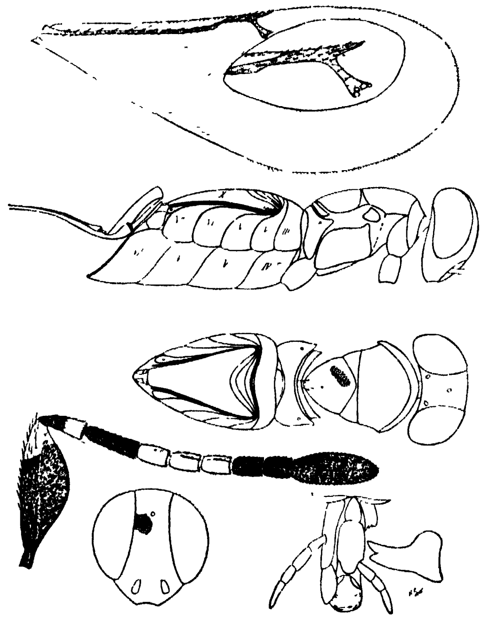

Fig. 7. *Apoanagyrus californicus* n. sp. Female.

appear white in point-mounted specimens and transparent in balsam-mounted specimens clothe the collar of pronotum, the mesoscutum, sides of propodeum, and basal corners of the abdomen.

The opaque effect on the axillae and scutellum is produced by closely spaced, coarse reticulations which appear velvety in tag-mounted specimens.

Head, dorsal aspect, slightly more than one and one-half times as wide as long; frontovertex as long as wide. Head, frontal aspect, longer than wide, the eyes reaching downward four-fifths of the way. The eyes are less protuberant and not so long as in *Leptomastix*, the cheeks longer and less strongly convergent.

Scape about two and one-half times as long as wide, widest at the middle, the expansion as in *Anagyrus*. Pedicel two and one-half times as long as wide, plainly shorter than the first funicle segment. First segment of the funicle plainly much the longest, slightly more than three times as long as wide, and as long as the succeeding two segments together; segments two to six subequal, each slightly longer than wide. Club somewhat longer than the apical two segments of the funicle, and about one and one-half times as wide.

Male.—Antennae with long, slightly curved hairs, arranged in two and three whorls on segments of the funicle. As previously mentioned, small scalelike hairs stand erect in a row on the sixth funicle and first club segments.

Fifty females and ten males were selected as type specimens, all of which were reared from *Phenacoccus solani*, in the insectary at Riverside, by Maple, in 1935. Presumably, the mealybugs from which these issued were collected in Riverside city, or near by.

Apoanagyrus sp.

In Maple's paper, "The Eggs and First Instar Larvae of Encyrtidae and Their Morphological Adaptations for Respiration," mention is made of an *Anagyrus* n. sp., represented by one female only. Among Maple's specimens are the trophi and appendages of a single female mounted in balsam. Presumably, these parts are from the specimen mentioned by Maple, and associated with these female parts are four male specimens. Two of these males are entire; the other two were dismembered and only the trophi and appendages preserved.

This species, mentioned by Maple as *Anagyrus* n. sp., belongs to the new genus *Apoanagyrus*. In the female it can be distinguished from *Apoanagyrus californicus* n. sp. by the length of the first segment of the funicle. In this unnamed species the first segment of the funicle is subequal in length to the pedicel, and scarcely longer than the second segment.

The Species of Anagyrus Occurring in California

Seven species of *Anagyrus* are now recorded as occurring in California. One of these, namely *ferrisi* Compere, appears to be indistinguishable from *subalbicornis* (Girault). In turn, *subalbicornis* is in close agreement with *yuccae* (Coquillett). In the present paper, *ferrisi* Compere is made a synonym of *subalbicornis* (Girault) on the basis of a comparison of specimens of the type series. Whether or not *subalbicornis* (Girault) is a synonym of *yuccae* (Coquillett) remains undetermined, owing to the lack of authentically identified specimens of *yuccae* for comparison.

Key to the Species of Anagyrus Occurring in California

1. Flagellum partly white 3
   Flagellum entirely black 2

2. Scape about one half as wide as long. Postmarginal vein as long as or longer than the stigmal vein. Front wings about twice as long as wide . . . . . 1. *fusciventris* (Girault)
   Scape scarcely one third as wide as long. Postmarginal vein plainly shorter than the stigmal vein. Front wings about thrice as long as wide . . . . . 2. *nigritus* (Howard)

3. First two or more segments of the funicle black 5
   First segment of the funicle black, the succeeding segments and club white 4

4. Scutellum with eight long black hairs at apex. Hind femora and base of hind tibiae brown, remainder of legs yellowish . . . . . 3. *yuccae* (Coquillett)
   Scutellum with four long black hairs at apex. Legs yellowish or straw-colored, the femora and base of tibiae of hind legs concolorous. In some specimens the legs are more or less suffused with brownish, but this is not limited to definite areas on the hind legs . . . . . 4. *subalbicornis* (Girault)

5. First two segments of the funicle black . . . . . 5. *clauseni* Timberlake
   First four, or rarely first three, segments of the funicle black . . . . . 6. *putonophilus* n. sp.

1. **Anagyrus fusciventris** (Girault)

Epidinocarsis fusciventris Girault, Mem. Queensland Mus., 4:144, 1915*b*
Anagyrus nigricornis Timberlake, Proc. Hawaii. Entom. Soc., 4:197, 1919. Compere, Bull. Entom. Res., 34:129–130, 1943.

2. **Anagyrus nigritus** (Howard)

Aphycus nigritus Howard, Proc. U.S. Nat. Mus., 21:241–243, 1898.
Anagyrus nigritus Timberlake, Univ. Calif. Publ. Entom., 3:224–226, 1924.

3. **Anagyrus yuccae** (Coquillett)

Blastothrix yuccae Coquillet, West. Amer. Sci., 7:44, 1890.
Anagyrus yuccae Timberlake, Univ. Calif. Publ. Entom., 3:224–226, 1924.

In the original description, Coquillett states that the apex of the scutellum bears eight long black bristles. Timberlake, who examined the specimens of *Anagyrus* in the U.S. National Museum, made the following note, in 1914: "*Anagyrus* 2 females from grape mealybug. Like *yuccae* but considerably darker. Bristles on scutellum of type of *yuccae* do not show very well. There are at least two rather long ones at or near apex, and a pair of short ones in front of the apical pair." The two females from grape mealybugs were described by Girault later as *subalbicornis*.

It is difficult to understand how Coquillett could have made a mistake in his statement regarding the number of spinelike setae at the apex of the scutellum in *yuccae*. In the present paper it is assumed that Coquillett was correct, and that some of the setae were rubbed off before Timberlake examined the types.

The number and distribution of spinelike setae on the scutellum provides a character of some value in differentiating between species of *Anagyrus*.

4. **Anagyrus subalbicornis** (Girault)

Epidinocarsis subalbicornis Girault, Psyche, 23:44, 1916.
Anagyrus subalbicornis Timberlake, Univ. Calif. Publ. Entom., 3:224–226, 229–231, 1924.
Anagyrus ferrisi Compere, Univ. Calif. Publ. Entom., 4:18–22, 1926.

This species was described from two females, California State Insectary No. 675. A series of specimens in the collection of the University of California Citrus Experiment Station, bearing the same data, may be regarded as topotypes, since these specimens and those studied by Girault were from the same rearing. So far as can be seen, these specimens of *subalbicornis* are indistinguishable from *ferrisi* Compere, and the latter is a synonym.

Timberlake, who compared *Anagyrus subalbicornis* (Girault) with the type of *Anagyrus yuccae* (Coquillett) in 1917, noted no structural differences between the two. In Timberlake's (1924) key to the North American species of *Anagyrus*, *subalbicornis* and *yuccae* are separated on the basis of slight differences in color. In the present paper, *subalbicornis* is separated from *yuccae* on the assumption that the latter species was correctly described by Coquillett with regard to the number of spinelike setae on the scutellum.

5. **Anagyrus clauseni** Timberlake

Anagyrus clauseni Timberlake, Univ. Calif., Publ. Entom., 3:226–229, 1924.

6. **Anagyrus putonophilus** n. sp.

The best clue to the identity of this species is provided by the color of the antennae. Generally, the first four segments of the funicle are black. In some specimens the color of the fourth segment is partly brown or black, with the remainder yellowish or white. Under the name *Epidinocarsis foersteri*, Girault described an Australian species as having the antennae colored similarly to this new species. The Australian species was described as orange yellow with black markings. In the species described here, the dorsum of the thorax is black to dark brown, with some faint indication of orange yellow.

Female.—Dorsum of thorax and the abdomen black to dark brown; collar of pronotum and tegulae dirty white; mesopleura orange. Frontovertex orange yellow, lower face and cheeks blackish suffused with orange; temples and occiput blackish. Legs brown with varied and extensive suffusions of blackish. Scape black with the usual preapical oblique whitish crossband; extreme base of scape and apex of pedicel tipped with whitish; first four funicle segments usually black, the fifth and sixth, and the club, straw-colored.

Frontovertex about as long as wide. Ocelli in a trifle less than a right angle; the posterior pair about once their own diameter from the eye and occipital margins. Eyes with numerous, short, coarse blackish hairs. Head, thorax, and abdomen with the usual clothing of silvery hairs. Wing veins somewhat darker than usual; marginal and postmarginal veins subequal in length, the latter plainly shorter than the stigmal vein. Speculum interrupted by three or four rows of hairs.

Scape about twice as long as wide. First segment of the funicle plainly the longest, and slightly longer than the pedicel, slightly more than three times as long as wide. The segments of the funicle all progressively decrease in length, the sixth longer than wide.

Described from 30 specimens reared from *Puto yuccae* (Coq.) collected at Fillmore, California, by J. D. Maple at different times in the summers of 1935 and 1936. Maple's No. 500.

CLAUSENIA SP.

The species mentioned in Maple's paper under *Clausenia* is represented by the trophi and appendages of two females. These bear the label "Johannesburg, Transvaal, May, 1937. H. Compere, coll." Presumably, the specimens were submitted to Timberlake and identified by him as *Clausenia* sp. Subsequently, Maple dissected the females to study the eggs, and then mounted the trophi and appendages, as was his custom.

THREE SPECIES INCORRECTLY CLASSIFIED

The two species *Baeoanusia oleae* (Silvestri) and *B. minor* Girault are out of place in the genus *Baeoanusia*, for the genotype of *Baeoanusia* belongs to the tribe Ectromini, whereas the two species mentioned here belong to the Mirini. It is possible that a new genus should be erected for these two species, but before this is done, a comprehensive study should be made of their generic relationships.

A third species that is now regarded as incorrectly placed is *Eusemion californicum* Compere. This species is to be made the type of a new genus in a paper now in preparation.

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THE EGGS AND FIRST INSTAR LARVAE OF ENCYRTIDAE AND THEIR MORPHOLOGICAL ADAPTATIONS FOR RESPIRATION

BY

JOHN D. MAPLE

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The President of the United States takes pride in presenting the BRONZE STAR MEDAL posthumously to

LIEUTENANT JOHN DINWIDDIE MAPLE, HOSPITAL CORPS
UNITED STATES NAVAL RESERVE

For service as set forth in the following:

CITATION:

"For meritorious achievement while serving as Member of the First Advance Party of United States Naval Medical Research Unit Number Two in furthering the development and introduction of techniques of aircraft spraying of DDT for the control of disease-transmitting insects in the Southwest Pacific War Area from April 23, 1944 to April 11, 1945. Working tirelessly and with superb efficiency, Lieutenant Maple rendered invaluable service in conducting biological tests under field conditions and in instructing malaria control personnel on Guadalcanal in the use of DDT for mosquito control. In addition, he assisted in the formulation of general plans and procedures to be followed in preparation for our operations against enemy-held Peleliu and Iwo Jima, and at Okinawa, supervised the technical aspects of aircraft-spraying activities during the initial stages of the campaign. Mortally wounded when his plane crashed during an extremely hazardous spraying mission over Okinawa on April 11, Lieutenant Maple, by his outstanding professional ability and sound judgment, had contributed to the saving of many lives and to the successful use of a new method for controlling disease in the future. His conscientious devotion to duty throughout reflects the highest credit upon himself and the United States Naval Service. He gallantly gave his life in the service of his country."

For the President,
(s) JAMES FORRESTAL
Secretary of the Navy

FOREWORD

THIS PUBLICATION is based principally on research conducted by John Maple in the course of his graduate studies in the Division of Beneficial Insect Investigations at Riverside, 1935–1938. The report was revised and expanded by him from time to time, and was submitted in final form as a thesis in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the University of California in 1940. This final revision was made in Japan, where Maple was engaged in the collection and shipment of beneficial insects to the United States for the U. S. Department of Agriculture. It was then expected that the manuscript would be submitted to the University of California Press for publication in the Entomology series, but the war made this impossible. Before peace came the author met tragic death on Okinawa.

The manuscript represents an outstanding contribution to knowledge of the biology of the Encyrtidae, a family of parasitic insects of great economic significance. The importance of the work is such as to justify its posthumous publication. Slight revisions of certain statements on biologies have been made by Stanley E. Flanders in order to bring them in line with recent discoveries. These are indicated. Also, the bibliography has been brought up to date. Otherwise, except for routine editorial changes, the paper is as the author submitted it.

HARRY S. SMITH
Professor of Biological Control
Entomologist, Experiment Station

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THE EGGS AND FIRST INSTAR LARVAE OF ENCYRTIDAE AND THEIR MORPHOLOGICAL ADAPTATIONS FOR RESPIRATION

BY

JOHN D. MAPLE

INTRODUCTION

THE FAMILY ENCYRTIDAE is one of the most important families in the order Hymenoptera. Since it is a member of the superfamily Chalcidoidea, it quite naturally possesses peculiar adaptations of great biological interest.

Encyrtids attack many kinds of hosts, the most numerous of which are the scales and mealybugs (Coccidae), a group of great economic importance, particularly in California. One of the functions of the Citrus Experiment Station of the University of California is to search in foreign countries for parasites of coccids and to undertake their introduction, propagation, and liberation. As a result of this work, a number of species of Encyrtidae were available for study, and the quantity of material offered excellent opportunities for research. In addition to the introduced and established species, I discovered a large number of endemic species of Encyrtidae.[1]

This study of the peculiar adaptations of the encyrtid egg and larva was prompted by an observation on the biology of one of the introduced species at the Citrus Experiment Station reported to me by S. E. Flanders. While engaged in the propagation of *Leptomastix dactylopii* How., a parasite of *Pseudococcus citri* (Risso) introduced from South America in 1935, Flanders observed a white elongate area on the deposited egg of the parasite. Since the white or silvery color gradually, yet irregularly, disappeared when the eggs were compressed in certain solutions, he concluded that the silvery appearance was due to air contained in that portion of the egg shell. Searching the literature for a similar phenomenon, Flanders found that F. Silvestri had arrived at the same conclusions with regard to another species of Encyrtidae nearly eighteen years earlier. However, Flanders also noted that the young larvae of *Leptomastix dactylopii* had their spiracles firmly attached to the silvery area. Having observed a similar vital connection between the eggs and young larvae of an *Anagyrus* parasitizing the mealybug *Puto yuccae* (Coq.), I (Maple, 1937) sought other encyrtids for a comparative study.

DEFINITION AND SCOPE OF INVESTIGATIONS

The ovarian egg of Encyrtidae is like a dumbell in shape, consisting of two more or less distinct bodies with a narrow connecting tube. This type of egg, however, is not peculiar to Encyrtidae, for similar shapes can be found in other chalcidoid families and in other superfamilies of Hymenoptera. It has been stated that this shape enables a large egg to pass through a small ovi-

[1] [The new species included in this study were described by Compere (1947) in order that they might be designated by name in this paper. S.E.F.]

positor. In some of the parasitic species the connecting tube may also serve as a stalk for adherence to external surfaces or to internal organs. In fewer species it may remain inserted in the integument of a host insect and serve merely as an anchor.

In the Encyrtidae, however, the structure has a distinctly peculiar significance. In the deposited egg a part of the connecting tube may remain exterior to the host, the remainder passing through the integument to suspend within the host the portion of the egg in which the embryo will develop. The larva upon hatching may remain with its posterior end enclosed by the egg shell. If it is provided with spiracles it may respire air conveyed by the connecting stalk.

Silvestri (1919) showed only that the shells of some encyrtid eggs were structurally modified to contain air after deposition. He ascribed no function to this structure. I believed that the young encyrtid larva, if provided with an open tracheal system, obtained atmospheric air directly from this structure and that the lumen of the stalk which suspends the larva did not serve this purpose in any way. As a corollary it was contended that a larva with caudal spiracles is enabled to respire atmospheric air by no other means. Accordingly this investigation was begun to seek the validity of these contentions.

An investigation thus defined would entail a study of structure and function. It was not possible for me to conduct exhaustive research in either morphology or physiology. Only the gross structure end, to a lesser extent, the internal structure were examined. From the beginning it was apparent that the physiology of respiration was a manifold problem warranting independent investigations and could not well be included in the scope of this study. It was determined to undertake a limited number of simple experiments which would throw some light on the role of the egg shell in respiration. In the main the subject was approached with respect to comparative morphology. Although the Encyrtidae is a large family and a study of the eggs and larvae of all known species would be an almost endless undertaking, I sought to include a representative number of genera from a variety of hosts. Included in this work, therefore, are parasites attacking seven orders of insects, namely, Homoptera, Hemiptera, Neuroptera, Lepidoptera, Coleoptera, Diptera, and Hymenoptera. Emphasis was inevitably placed on species attacking the family Coccidae of the Homoptera because of the abundance of native and introduced species parasitizing that group. For data concerning other hosts, I have drawn largely upon the literature. Species known to be polyembryonic were excluded since these have been abundantly studied and the mode of development is such that the egg shell could not conceivably play any role in larval respiration of atmospheric air.

PROCEDURE AND TECHNIQUE

Acquisition of Material

Material was obtained by insectary propagation and field collection. During the course of this work the University of California Citrus Experiment Station was particularly active in the introduction of scale and mealybug parasites,

a large number of which were Encyrtidae. Through the courtesy of Professor Harry S. Smith, in charge of biological control work, adults of certain of the species and host material were made available.

Most of the species were secured from field-collected material. Quantities of any insect known to be attacked by encyrtids were gathered and caged for possible emergence of adult parasites. The variety of parasite species obtained by this means was considerable.

All parasites obtained were fed undiluted honey immediately after emergence. Pending a suitable opportunity for study they were refrigerated at 36° to 40° F. and removed every week to the laboratory for feeding. When stored in this manner they could be kept alive in excellent condition for several weeks.

Examination of Ovarian Eggs

For an investigation of the ovarian eggs the abdomen was severed from the body in Ringer's normal salt solution and slit open along both sides.[2] The ovaries were removed intact. For cursory examination they could be mounted in the dissecting solution.

For detailed study further treatment was necessary. After dissection, most of the fluid was drawn off and a drop of stain solution applied. The only stain at all suitable was a solution of acid fuchsin in lactophenol.[3] A minimum of five minutes was necessary to produce an effective coloration. For mounting, the stain was removed as much as possible and a drop of Hoyer's solution added. The cover glass was carefully pressed so as to spread the ovarioles and straighten the eggs which are often coiled in the ovarioles. The slides were immediately examined, the egg sketched with the aid of a camera lucida, and the dimensions determined.

Mounts prepared in this fashion are not completely satisfactory. The most serious disadvantage is the lack of permanency. After several months, Hoyer's solution tends to crystallize and the stain begins to fade. It is believed that crystallization was avoided by placing slides in a warm oven until the mounting medium was sufficiently hard for ringing the cover slips with shellac. It has not been possible wholly to eliminate the defects of preparation. The technique can also be criticized on the grounds of distortion of the eggs. Pressure applied to the cover glass causes the eggs to expand, and as a result the measurements of eggs of a species differ and the shape does not resemble that of the freshly dissected egg. I believe that exact measurements are of little consequence and that measurements need only indicate relative size. Furthermore, without pressure on the cover glass, detailed examination would have been almost impossible. The fact that the mounted egg is not exactly like the freshly dissected egg is of no importance. The latter is invariably coiled, twisted, and partly collapsed. The mounted egg appears more like the normal deposited egg than the freshly dissected one does and its stfucture can be more accurately ascertained.

[2] Usually encyrtids contain eggs immediately after emergence, but in several species the females lacked mature ovaries. These were all from single generation scales and had emerged from fully developed hosts at a period when no stages of that host were suitable for attack.

[3] Suggested by the preparation outlined by Langeron (1934). It consists of 50 grams phenol, 50 cc lactic acid, 50 cc distilled water, and ½ gram acid fuchsin.

Securing Oviposition

Since most of the species studied attack Coccidae, the problem of obtaining oviposition was largely concerned with that group. The technique used was dependent upon the type of host and the stage attacked. If the hosts were mealybug-like (motile in nymphal and adult stages) the chances of success were more favorable than if they were scalelike (usually sessile in the later instars). Many of the former can be grown rapidly and in quantity on potato sprouts in the insectary. Female parasites could be placed on the infested sprouts and the hosts removed as parasitized, or a host could be isolated in a capsule for parasitizing. Usually this type of host could be isolated without food for a period sufficient for a study of the early stages and in some specimens for complete development. When very small stages were attacked, it was necessary to supply the food plant. Those species that could not be insectary grown were obtained from the field in suitable stages, parasitized, and isolated in capsules.

Parasites of scale insects posed more of a problem, particularly field-collected species. The females of some did not develop mature ovaries nor could development be induced. Others, in condition to oviposit, emerged at a time when hosts suitable for attack were not available. Some species attack hosts not readily reared, but when this happened the scale hosts could sometimes be kept alive on twigs of the host plant until a study of the early stages was completed. To avoid needless dissection, hosts were marked with a small drop of India ink as they were attacked.

Inevitably there were species that would not ovipost or that showed little interest in the coccid host during the experiments; but with most of them limited oviposition was eventually obtained. In the Encyrtidae mating is fortunately not a prerequisite of oviposition.

In this investigation the only noncoccid hosts of which complete studies of egg and larva were made were two species of Hemiptera. Since these hosts were attacked in the egg stage, the technique employed was relatively simple. They were exposed to parasitization in a vial. The number of female parasites was of no consequence unless they tended to interfere with one another. Once oviposition commenced the egg mass could be removed and the oviposition process observed. As each egg of an egg mass was parasitized, that egg was checked off on a diagram of the group.

It is always advisable to expose many individuals of the host for parasitism. The reasons for this are:

1) Eggs may not be deposited when the host is attacked.

2) There is always the possibility of loss from mortality by accidental or natural causes.

3) Numerous dissections are often necessary in order to confirm an observation.

4) If the species can be propagated it is highly desirable to maintain a stock for possible future work and to secure an adequate series for taxonomic purposes.

Studies of the Deposited Egg

First, the location of the deposited egg was sought by inspection of the host. If the eggs are attached to the integument, that portion which protrudes from the host may sometimes be distinguished, since it looks like a clubbed white seta. If the host has a roughened surface or is covered with wax, examination is tedious. When the entire host was placed in the stain solution used for the ovarian egg study, the stalk readily colored, whereas the host integument remained unchanged. The wax had to be removed from mealybugs to permit the stain to reach any stalk. It was more convenient to dissolve the wax with xylene, but since this solvent penetrates the egg, it was necessary to scrape the wax off carefully.

Upon dissection eggs were often found imbedded in host tissue. The host's integument could be pulled away with the egg attached, but there was less possibility of destruction if the eggs were freed from the tissue and the integument surrounding the stalk was excised.

In those species that did not deposit eggs attached to the host's integument, the egg was not readily found. It was then often necessary to watch the oviposition procedure, to record the exact spot, and to dissect cautiously around the area. Many eggs of this type are easily confused with the body contents of the host and the latter must be slowly examined for any egglike bodies. When these methods failed, the hosts were dissected in aceto-carmine, which stains the host's tissues and not the parasite eggs.

The deposited eggs were examined unmounted in the dissecting fluid and sketched. No measurements were made as they were not believed to have any bearing on the problem.

Studies of the Larva

The chief objective of the larval studies was to determine the type of tracheal system. From experience it was learned that the tracheae, when present, became obscure soon after the larva hatched. This seemed to be caused, in part at least, by the quantity and opaqueness of consumed food. During or immediately after eclosion, feeding begins and the major portion of the larva fills with colored host contents. This obstacle to observation was avoided by securing fully developed embryos. The shell of the egg is transparent and the tracheae appear almost invariably before eclosion. The margin of time for study, however, is very narrow. It was therefore necessary to parasitize a series of hosts and record the exact time of egg deposition in each one of the series. Dissections were then made at intervals until the information was obtained. In the meantime all material was kept at a constant temperature.

At first there were errors in the determination of the proper intervals for observation; however, experience reduced the number of mistakes. The deposited eggs of all species were examined 24 hours after deposition. (None was found to hatch prior to that time.) An examination of the contents of the egg disclosed the degree of embryonic development and the proximity of eclosion. At deposition the egg is white and opaque, and as development

proceeds it gradually becomes translucent. This change commences at the periphery of the egg. The opaque portion, which is yolk, gradually becomes smaller but never disappears before eclosion. Eclosion occurs soon after the yolk body occupies one-third or less of the volume of the egg. By this time the stomodeal regions and frequently the tracheae may be apparent. Dissections therefore should be made every few hours thereafter. Embryonic development was usually 12 to 24 hours longer when the eggs were deposited free than when the eggs were attached to the integument. Consequently in examinations of the free eggs, the first interval could be extended to avoid waste of material.

The embryos or larvae were mounted and the higher magnifications of the microscope were used. At first, the different stages were mounted in the dissecting solution, but much skill was required. Too much fluid would float the material from under the cover glass or shift its position while it was being sketched. Examinations had to be rapid, for as the water evaporated the cover glass would descend to flatten the specimen. By use of a simple expedient these difficulties were largely eliminated. Small bits of modeling clay were placed at four or more equidistant places on the circumference of the cover glass, which was then lowered directly over the egg or larva floated in a very small drop of salt solution. While being watched under a binocular microscope, the cover glass was carefully pressed until it just touched the specimen; then, by means of gentle pushing at the sides of the cover glass, the material could be rotated on the longitudinal axis with little danger of rupture, and the egg or larva could be held in any desired position. As the water in the salt solution evaporated, distilled water was added. Observations could be made with ease over an extended period and there was little need for repetition which would diminish a limited stock of material.

Some embryos had not quite reached the development desired. Normal development was resumed for as long as 24 hours, however, when an egg was placed in a culture slide containing normal salt solution. Periodic observations were then easily made and the embryo could be obtained in the desired state of development. Certain phases were examined by these means that could not otherwise have been studied without numerous dissections. It is doubtful, however, if the resulting eclosion was normal; usually the embryo did not hatch even though it was completely developed.

The same technique was used for first instar larvae.

THE EGGS

Definition of Terms

The terms applied by investigators of encyrtid biologies to structures of the egg have been many and sometimes poorly descriptive of the true form or function. So far as possible I have eliminated the less desirable without adding new words or expressions.

The encyrtid egg is shaped like either a dumbbell or Indian club and consequently is called "double-bodied egg." The body, or posterior portion which is deposited first, contains the embryo and is therefore the "egg proper" or

"egg" in its narrowest sense. The second body, or anterior portion bears the micropyle. Since in the process of oviposition this body collapses and its contents are forced into the egg proper, the designation "bulb" seems quite applicable. The bulb is joined to the egg proper by a narrow tube called the "neck." Although this structure has been commonly referred to by others as the "pedicel" or "stalk," I reserve these terms for neck and bulb collectively when the egg is in the deposited state, particularly with regard to those eggs that are attached to the integument of the host and partly protrude from it. Investigators have used the terms "stalked" or "pedicelated" eggs with reference to such eggs when deposited. I found this structure to be composed of two parts, the collapsed anterior body of the ovarian egg (bulb) and the connecting tube (neck). To avoid confusion "stalk" and "pedicel" are retained, but applied only to the combined structures.

For the terms pertaining to the egg shell, I have relied on the publications of F. Silvestri, since no other investigator has described and drawn these complicated structures. The reticulations on the egg proper Silvestri called the "band," "aeroscopic plate," and "respiratory plate." Since the reticulations are also found on the neck, I use these terms to designate the entire structure. They may be used almost interchangeably. "Band" indicates this structure when the egg is in the ovary, "aeroscopic plate" suggests its form and "respiratory plate" its function after deposition of the egg. Since its function is still more or less theoretical, the use of "band" or "aeroscopic plate" is preferable.

Comparative Morphology

It is common practice in a comparative study to attempt a classification of the various forms. In this work eggs are segregated primarily as an aid in discussion.

According to structural complexity, eggs may be divided into three groups: unbanded, modified or banded, and intermediate.

UNBANDED TYPE

Ovarian Egg.—The unbanded type of encyrtid egg is the simplest in form. There is no modification of the chorion whatsoever. Yet, like all encyrtid eggs, they are double-bodied; that is, there is a bulb, neck, and egg proper. There is little or no indication, however, of where the bulb ends and the neck begins. For convenience the neck was considered to be only that central portion which is uniform in diameter. The anterior point of increase in width was considered to be the beginning of the bulb.

The bulb is often only slightly wider than the neck, as in *Quaylea whittieri* (fig. 8, *B*) or *Eusemion californicum* (fig. 40), and in no species was it observed to be greater in width than the egg proper. The neck is of variable length. In *Quaylea* it is several times longer than the egg proper and in *Acerophagus pallidus* so short as to be almost nonexistent. The posterior end or egg proper is variable in shape. In many species it is broadest toward the neck, pointed at the apex, and dorso-ventrally more or less symmetrical. The smallest eggs are of this type, those of *Acerophagus* spp. being typical. In other

relatively large species the egg proper is convex on the ventral side and only slightly convex or concave on the other. Among these species are found the largest eggs in the family. The eggs of *Cheiloneurus* spp., *Homalotylus* sp., and *Eusemion californicum* are notable examples.

Deposited Egg.—All the evidence at hand indicates that the eggs of the unbanded type are deposited completely free within the host. *Pseudaphycus angelicus* was, however, the only species investigated by the writer. In this the twisted and collapsed bulb is doubled back over the neck and soon melanizes to a light brown color. Other species which deposit their eggs intact are *Cerapterocerus mirabilis* and *Aphidencyrtus aphidivorus* (Silvestri, 1908), *Zarhopalus corvinus* (Clausen, 1924), *Comperiella bifasciata* (Compere and Smith, 1927), *Cheiloneurus noxius* (Le Pelley, 1937), and *Chrysopophagus compressicornis* (Clancy, unpublished).[4] Some of these eggs appear occasionally to be affixed to tissue, but in no species did the neck pass through the host's outer surface to form a projecting stalk.

The neck and bulb usually remain intact though they may be shriveled and collapsed. That the chorion may be unbroken was demonstrated with *Pseudaphycus angelicus.* A parasitized mealybug was dissected immediately after it was attacked. As rapidly as possible the egg was mounted in Hoyer's solution and pressure applied to the cover glass while the slide was examined under a microscope. Some of the contents of the egg proper entered the neck and returned to the bulb, as shown in figure 64, *B*. The egg could not, however, resume the original shape. When the eggs remained in normal salt solution for fifteen minutes or more, compression would burst the egg without reinflating the bulb.

The stalks or pedicels of these eggs eventually break off or disappear, and the shell may then be so weakened or so ruptured that eclosion of the larva is aided.

The eggs of several species, namely, *Cheiloneurus inimicus, Cheiloneurus noxius, Chrysopophagus compressicornis, Eusemion cornigerum, Tetracnemus pretiosus,* and *Zarhopalus corvinus,* have been reported by the various investigators to increase enormously in size after deposition.

BANDED TYPE

Ovarian Egg.—In this type the ovarian egg is more definitely two-bodied than in the unbanded type. The bulb is prominent and often larger than the egg proper. It is usually longer than wide, but sometimes is nearly spherical. The shell is pliable and elastic so that the shape varies in mounted material. The shell is sometimes thickened at the apex and has been said to bear the micropyle.

The neck varies greatly in length. In *Encyrtus fuliginosus* (fig. 30, *A*), it is shorter than either the bulb or the egg proper. In other species, such as *Microterys flavus* (fig. 51, *A*), *Phaenodiscus aeneus* (fig. 63), *Ooencyrtus johnsoni* (fig. 59, *A*), and *Diversinervus elegans,* the neck is two or more times as long as the egg proper. The diameter of the neck is proportionate to the size of the

[4] [Published in 1946. S.E.F.]

other bodies and is usually uniform throughout. In a few species the anterior end of the neck is swollen. This enlargement is correlated with band structure.

The egg proper has a typical shape. The dorsum is always flattened (at most slightly convex) or concave, and the venter invariably convex. The shell is comparatively firm though pliable.

These eggs are distinguished from other encyrtid eggs (and apparently those of all Hymenoptera) by the band or aeroscopic plate. On the neck and egg proper the shell may give the appearance of being sculptured in certain areas. These areas form a stripe down one side of the egg; hence the term "bands." Silvestri (1919) figured and described this structure on the eggs of five species, *Blastothrix sericea, Phaenodiscus aeneus, Encyrtus infidus, Metaphycus melanostomatus,* and *Microterys masii.* Strangely enough, his findings have been completely overlooked. Embleton (1904) probably saw the band on *Encyrtus infelix* because she described a portion of the stalk as having "an appearance of fine papillations or striations on the wall of the tube." Smith and Compere (1920) unquestionably found the same structure when they described a "ventral rib or stay" which extended about two-thirds the length of the egg of *Metaphycus lounsburyi,* giving it rigidity when the egg was inflated.

The band usually occurs on the flat dorsal surface of the egg. With *Encyrtus infelix* and *E. fuliginosus,* however, the curved ventral side bears the band. Even this genus is not uniform in this respect. *Encyrtus infidus,* according to Silvestri, has the dorsal surface banded.

Although the shape, size, extent, and composition of the band vary among species, they are essentially constant for any one species. An examination of the figures will show that no two bands are exactly alike. Most bands extend two-thirds to three-fourths the length of the egg proper. In *Metaphycus melanostomatus* (fig. 48) the band extends only half the length, in *Blastothrix longipennis* it is approximately one-third the length (fig. 13), and in *Encyrtus infelix* and *E. fuliginosus* it is almost the full length of the egg proper. There is much variation in width: it is broad in *Coccidoxenus niloticus* (fig. 21) and narrow in *Metaphycus flammeus* (fig. 66, *A*). The width may be uniform throughout the length (*Metaphycus luteolus,* fig. 47), or irregular (*Erythraphycus argyrocomus,* fig. 35). Some are pointed at the apex; others are rounded. Several species of *Ooencyrtus,* e.g., *O. johnsoni* (fig. 60), have the tip of the band forked.

The bands may be similar in shape and extent but different in composition. Large cells mixed in with smaller ones form a pattern of hexagons with *Coccidoxenus niloticus* (fig. 21) and elongate polygons with *Microterys flavus* (fig. 51). The cells in the band of *Erythraphycus argyrocomus* (fig. 35) are more or less uniform in size. In *Metaphycus howardi* (fig. 44) cell uniformity is broken by a patch of larger cells. The bands of *Ooencyrtus johnsoni* and *O. californicus* are exceptional in that throughout most of the middle area the cells are scattered. Differences are also apparent on the neck of the band. The diameter is usually the same throughout, but in *Anagyrus putonophilus* (fig. 3, *A*), *Coccidoxenus niloticus* (fig. 22, *A* and *B*) and *Pseudleptomastix squam-*

mulata (fig. 66, *B*), the neck is swollen near the bulb and the cells of the band at that point are large. Midway on one side of the neck in *Encyrtus infelix* and *E. fuliginosus,* there is a prominent projection (fig. 31) called the lip, which is actually a part of the band. In *Ooencyrtus johnsoni* (fig. 59, *B*), and *O. californicus,* a portion of the anterior end of the neck has a thickened wall. This is lacking in *O. kuvanae.* The band extends completely around the anterior end of the neck in only a few species—*Ooencyrtus* and a few others. Usually it does not cover more than half. The egg of *Anagyrus putonophilus* (fig. 3, *A*) has a collar or jutting, thickened area on the neck, without cells, the band passing underneath. A similar structure is found on the eggs of the intermediate type.

Banded eggs are by no means rare. Of the 61 species I examined, the eggs of 30 were banded; 14 out of 26 species recorded in the literature apparently have banded eggs. Of the total species in this study half the number have banded eggs. The relative occurrence of the two types in the family is a matter of conjecture but it is certain that banded eggs are far more common than has been heretofore supposed.

Deposited Egg.—In the process of oviposition the portion of the egg in which the embryo will develop, the egg proper, is placed within the host and the neck projects through the derm or shell to the exterior. Embleton was probably the first to observe this peculiarity but Howard and Fiske (1911) more clearly described the host-egg-larva relationship with *Ooencyrtus kuvanae.* At least eight investigators have reported the same phenomenon. Of these, Silvestri (1919) has given by far the most detailed and lucid account.

In connection with the deposited egg of *Phaenodiscus aeneus* one notation of Silvestri is very significant: if the egg, while fresh, is examined in physiological solution or in glycerine, the petiole and the dorsal plate appear black throughout their length because of the presence of air. As noted previously, S. E. Flanders made similar observations fifteen years later with *Leptomastix dactylopii.* I also observed the deposited eggs of a number of species, and all appeared the same. With transmitted light the band on the egg proper and the neck is dull gray or black and, with reflected light, shimmering white or silvery. In some ovarian eggs the bands were not discernible.

Most investigators have believed that the bulb is completely destroyed during oviposition. I find that this is not usually the case. The stalk normally consists of the neck and the remains of the bulb. The portion projecting from the host consists mostly of neck but at its tip is the crumpled bulb. In only one species, *Encyrtus fuliginosus,* has the bulb been observed to be almost invariably missing.

The position of the egg in the host is such that the flatter dorsal side lies outward. Thus, with most species, the band on the egg is directly opposed to the surface of the host. With *Encyrtus infelix* and *E. fuliginosus,* the band is on the convex ventral side and is therefore on the side of the egg farthest from the host's surface.

The stalks of all such species project erect or nearly so. In a few species (e.g., *Coccidoxenus niloticus*) the anterior end of the neck is somewhat curved.

The collapsed bulb may be in a tight wad or extended at an angle to the neck.

In a number of species the deposited egg melanizes. Usually melanization is limited to those portions within the host and in most species observed it was confined to the band. Soon after the egg is deposited, this section may become yellow-brown or gray. The eggs of six species were melanized, namely, *Aenasius maplei, Erythraphycus argyrocomus, Microterys flavus, Microterys saissetiae, Ooencyrtus johnsoni,* and *Ooencyrtus californicus.* Clancy [1946] observed the band to become discolored in *Isodromus niger,* and Smith and Compere (1920) have noted that the stalk of the egg of *Metaphycus lounsburyi* darkens. In *Ooencyrtus johnsoni* and *Erythaphycus argyrocomus,* the posterior two-thirds of the egg does not melanize until much later. In the former the band and the anterior third of the shell both discolor. The distal half of the band on the egg of *Microterys* is a lighter yellow-brown than the proximal half.

Melanization of the egg of *Ooencyrtus* spp. is peculiar in that the thickened portion of the neck, apart from the band, becomes an opaque black. Furthermore, this need not occur within the host. The egg blackens when, as occasionally happens, it is misplaced at deposition and all or part lies outside. The cause of this discoloration is unknown. Possibly oxidation would have this effect. There seems to be no correlation with structure. It is noteworthy that the melanization may take place in the ovaries of females that have been dead for several hours. I noted this with *Ooencyrtus johnsoni,* and Clancy informed me that he observed the same to occur with *Isodromus niger.* Frequently, if not always, there is an agglomeration of discolored host material around the stalk immediately below the integument of the host.

INTERMEDIATE TYPE

The eggs of the intermediate type are similar to both unbanded and banded eggs. Such a grouping, though arbitrary, will be shown to be significant.

Ovarian Egg.—The undeposited eggs are constant in shape. The egg proper is more or less flat on one side and convex on the opposite side. The bulb may be smaller or larger than the egg proper. In size and general appearance the ovarian eggs are like many of the unbanded type, but there are modifications of the chorion which would align them more closely with the group exhibiting bands. The degree of semblance is variable.

The eggs least similar to banded eggs are those with "collars"—a thickening of the shell in the region of the neck. This projection is readily colored by acid fuchsin. Its position is usually somewhat nearer the egg proper than the bulb or approximately midway the length of the egg. With *Apoanagyrus californicus* (fig. 11, *B*), *Apoanagyrus* sp. (fig. 9), and *Melanaphycus fumipennis* (fig. 42), the collars project prominently on one side, but with *Clausenia* sp. (fig. 20) the thickening appears to surround the stalk. The collar with *Apoanagyrus californicus* (fig. 11, *B*) is bidentate. The egg of *Isodromus iceryae* was noted by Clancy to have a transparent cone-shaped projection on the neck near the egg proper, within which there appeared to be a smaller but inverted cone. However, the identity of this structure with the so-called "col-

lars" is a matter of conjecture. The possible significance of these neck structures is discussed in connection with the deposited egg.

In two species the eggs have a decided resemblance to the banded type, namely, *Leptomastidea abnormis* (fig. 11, *C* and *D*) and *Ectromatopsis americana* (figs. 27, *A*; 28, *B* and *C*). In the egg of *Leptomastidea* a small aggregation of cells restricted to the neck are as large and distinct as the cells of many true bands. The egg of *Ectromatopsis* perhaps could be classed with the banded type. On the anterior end of the neck there is a small cluster of cells. When the neck is viewed laterally, a row of very minute cells immediately below this cluster can be seen to extend the length of the neck. In the dorsal aspect no band is visible for a short distance below the cluster of cells; but thereafter it can be distinguished on the rest of the neck, though narrow and composed of minute cells. At the anterior end of the egg proper the band widens slightly. A bandlike area, devoid of cells, is discernible on the egg proper. On the anterior end of the neck there is a dentate collar which has a strong affinity for acid fuchsin. Above the collar the neck is bulbous or flask-shaped.

The egg of *Bothriothorax nigripes* has a vague resemblance to banded eggs. A fine line (fig. 17) extends along the neck for nearly its entire length. Though this stained readily, no cells could be found. No structures were visible on the egg proper and the neck is unornamented.

Deposited Egg.—Observations have shown that when the eggs of the intermediate type are deposited, the neck passes through the host's integument to project to the exterior; however, the attachment of the neck to the egg proper is extremely fragile. If dissections are not made immediately after oviposition and with enough precaution, the main body becomes disengaged and floats free. This fact undoubtedly accounts for the mention of free-floating eggs in *Leptomastidea abnormis* by Vierick (1915) and Smith (1917), and may explain similar records with other species which are said to lack a "pedicel" on the egg.

In the intermediate type, the portion of the egg left outside the host is less erect shortly after deposition than in the banded type, and may collapse entirely. If, as in *Melanaphycus fumipennis* (also *Isodromus iceryae*, according to Clancy) several eggs are laid in clusters or close together, the stalks may support each other and remain erect.

The deposited egg of *Ectromatopsis americana* may be more closely associated with the banded type. The attachment is quite firm. The narrow band on the neck has a silvery sheen immediately after deposition, but this sheen, which is considered significant in the light of larval structure and development, is lacking on the egg proper. The integument of the host surrounds the neck of a deposited egg immediately beneath the collar, if such a structure is present. Clancy informed me, however, that he found a similar structure on the egg of *Isodromus iceryae* completely within the host. No function was assigned to it. In either position these structures might serve as a sort of wedge to prevent the egg from slipping. Such a function, however, does not appear to be of any importance in this type of egg.

The bulb, though collapsed, probably remains intact. The experiment of inflating the bulb by crushing freshly deposited eggs was attempted with two species—*Melanaphycus fumipennis* and *Apoanagyrus* sp. Partial inflation was obtained with the former but none with the latter. There was a tangled membranous mass in the stalk of the *Apoanagyrus* which seemed to prevent any material from passing back into the bulb.

One instance of melanization was observed in which the portion of the stalk of the *Melanaphycus* egg lying within the host turned a gray color, visible through the host's integument, and thereby facilitated the location of the eggs.

STRUCTURE IN RELATION TO TAXONOMICAL AND BIOLOGICAL STUDIES

The classification of eggs may have considerable taxonomic significance. There are encyrtid genera in which the eggs of all the species studied belong to the unbanded type, e.g., *Cheiloneurus* and *Acerophagus,* or to the banded type, e.g., *Encyrtus* and *Metaphycus.* Since the intermediate type is indefinite, it is perhaps unlikely that genera exist which have such eggs exclusively. The egg of *Isodromus niger* according to descriptions by Clancy [1946] would belong to the banded type and that of *Isodromus iceryae* to the intermediate type. However, further taxonomic studies may reveal them to belong to two genera.

The egg structure also has some specific value since eggs may differ in type among species of a genus. Differences within the type, more particularly the banded group, are also of value. This is illustrated in my study on *Blastothrix* from lecanine scales. On the basis of adult characters the California encyrtid *Blastothrix longipennis* How. is regarded by such competent authorities as P. H. Timberlake and Harold Compere to be inseparable from *Blastothrix sericea* Dalm., and probably synonymous. I noted, however, that the band on the egg of *B. longipennis* was quite different from that described by Silvestri for *B. sericea.* On the basis of this evidence, as well as of minor differences, it seemed logical to assume that there are two species concerned, though the imagoes are as yet indistinguishable.

Specificity in egg structure may be of value in a study of the parasite fauna of a host. I had not been able to secure laboratory-deposited eggs of *Blastothrix longipennis* and recourse was had to field-parasitized scale. These scales had been heavily attacked by several encyrtids and aphelinids. There was only one egg the structure of which remotely resembled the ovarian egg of the *Blastothrix,* and it was assumed that this must be the deposited egg sought. Subsequently this appears to have been confirmed by rearing. *Blastothrix* emerged and the ovarian eggs of other species reared were the same as those found within the host scale.

Considering the great diversity in band structure, it might be thought that banded eggs are not difficult to distinguish specifically. The eggs of some species, however, are strikingly similar, e.g., *Ooencyrtus johnsoni* and *Ooencyrtus californicus.* The eggs of other species will probably be found to be indistinguishable. Without abundant evidence, the limitations of specificity cannot be defined, but most certainly a study of the egg structure can be of value in a biological investigation.

The presence of the band on the encyrtid egg enabled Flanders (1942) to demonstrate that the eggs of Hymenoptera are absorbed if they are retained in the ovary for lack of suitable oviposition sites. In *Clausenia* sp. (fig. 20) the ring bands, which remain unabsorbed, provide a record of all the eggs that have been produced and not deposited.

Oviposition

The manner in which the egg is deposited varies greatly among species and, to a minor degree, among individuals of a species. The only way in which oviposition in general could be classified would be according to its rate. Rate of oviposition is dependent upon three factors: speed of ovipositor insertion, ultimate destination of the egg, and number of eggs per insertion.

The penetration of the host's surface by the ovipositor is often the most time-consuming operation. For example, several minutes are required for *Ooencyrtus johnsoni* to bore a hole through the shell of the host egg. The shortest period was nine minutes but fourteen minutes or more may elapse. Other parasites require similar periods. Clancy [1946] found that the penetration of the *Chrysopa* integument by *Chrysopophagus compressicornis* was a lengthy process. On the other hand, with many parasites, particularly those attacking soft-bodied coccids, the ovipositor penetrates with one quick thrust.

The final position of the egg, as well as its structure, may influence the rate. The banded and intermediate types require the most time. These, we have seen, are placed with the neck projecting outside the host. The egg-laying procedure follows a definite course. Once the ovipositor is inserted, a distinct pause ensues during which the egg proper is presumably placed in position. The ovipositor is withdrawn, or nearly so, and then another pause occurs. The body of the female vibrates rapidly and fluid can be seen passing down between the stylets; then near the tip the stalk bows outward and the collapsed bulb suddenly springs free. If this process of oviposition is a matter of minutes, most of the time is consumed in placing the egg proper. After that the process is completed in a few seconds. However, with some parasites, for example *Encyrtus fuliginosus* and *Melanaphycus fumipennis,* the entire procedure is so rapid that all the steps are rarely apparent. The latter species is particularly remarkable in that egg-laying is complete in a few seconds. Ordinarily, deposition can be detected by watching the actions of a female, but in these two species it was very seldom possible to be certain of the deposition of an egg. Similarly, eggs of the unbanded type may be laid hurriedly or leisurely. As a general rule, however, oviposition requires only a few moments.

When single eggs are deposited, only a few seconds may be required. Parasites like *Pseudaphycus angelicus,* that may place a number of eggs in one host, take several minutes. A minimum period of five minutes and a maximum of twenty minutes has been noted. As many as twelve eggs may be laid at one insertion of the ovipositor.

Specific and individualistic behavior often prolongs the process. There is a minimum time of egg deposition for every species, but certain individuals may spend hours at the process.

FIRST INSTAR LARVAE

COMPARATIVE MORPHOLOGY

Encyrtid larvae of the first instar are conveniently classified into two groups, those with closed tracheal systems and those with open systems. This classification, unlike that based upon the grouping of the eggs, is on a firm functional basis.

TRACHEAL SYSTEM CLOSED

In this group the tracheae typically make one complete circuit in the larval body from the first to the ninth visible body segment. The lateral tracheal trunks make up most of the circuit, which is completed by connecting commissures at both extremities. The anterior commissure is longer than the posterior one and usually loops forward and above the fore intestine. In diameter it is smaller than the other tracheae in the circuit. Invariably there are cephalic branches at the points of union with the main trunks. The posterior commissure is of the same diameter as the lateral tracheae, or nearly so. It may loop dorsoanteriorly but is most often straight and short. Branches of the lateral tracheae are small and frequently indistinct.

There are species with tracheal systems which appear incomplete. With *Leptomastidea abnormis* (fig. 36) and *Apoanagyrus californicus* (fig. 7, *B*), only portions of the lateral trunks were discernible. The entire system probably exists, but could not be seen. Two species have been reported to have only partial systems. The larvae of both *Tetracnemus pretiosus* (Clancy, 1934), and *Anarhopus sydneyensis* (Compere and Flanders, 1934) are said to be devoid of trachea at eclosion but later develop a pair of rudimentary trunks (see fig. 67).

The so-called "atracheate" larvae are also placed in this group. I am of the opinion that many species reported to be without tracheae actually have a closed system. I experienced much difficulty in finding tracheae, and it is entirely possible that other investigators overlooked obscure respiratory filaments. Furthermore, a system may be present though not functioning in such a manner as to be distinguishable. To discern tracheae it has been necessary to depend upon the reflection and refraction of light. In direct light tracheae containing air have a silvery sheen and in transmitted light such tubes are black. If air is removed, tracheae disappear. It seems reasonable to suppose that the tracheal system sometimes does not contain air and would not, therefore, be observable by this method. I discovered that by examining fully-developed embryos, a tracheal system could be found; whereas after eclosion it was practically invisible. This method was habitually employed and the only species encountered that could possibly be atracheate in the primary stage was *Pseudaphycus angelicus*. No trace of tracheae could be found before or after eclosion.

Though the larvae of this group have a common type of respiratory system, there is a notable variation in body shape and none can be regarded as typical. In some species the larvae are almost perfectly spherical, e.g., *Pseudaphycus angelicus* (fig. 65), *Metaphycus melanostomatus* (fig. 49), and *M. timberlakei*

and *Melanaphycus fumipennis* (fig. 43). Others are broad in the head and thorax, tapering posteriorly, and crescentic in the lateral aspect, e.g., *Ectromatopsis americana* (fig. 29), *Apoanagyrus californicus* (fig. 10), and *Apoanagyrus* sp. (fig. 9). In some the posteriormost segment (or segments) may be greatly attenuated to form a "tail," e.g., *Cheiloneurus* sp. (fig. 19). Larvae of this shape are designated "caudate" or "tailed."

Some spherical larvae may possess an open tracheal system, but larvae that taper posteriorly or are attenuated to form a tail have never been found to have an open system. Larvae of the genus *Encyrtus* may be regarded as exceptional. In these, particularly the later instars, the posterior extremity is prolonged. The tail, however, is bifurcate and bears a spiracle at the tip of each process. Larvae with a single posterior process have no spiracles and the tracheal system terminates anterior to the tail.

Most larvae of this type leave the eggshell completely at eclosion. Only a few remain, entirely or in part, within the eggshell. The larvae of two such species, *Pseudaphycus angelicus* and *Melanaphycus fumipennis,* were noted to be almost completely enclosed by shell. Thus they may remain until body expansion bursts the shell. Clancy (1934) has shown that in *Tetracnemus pretiosus* nearly half the first instar is passed within the enveloping chorion. According to the description of *Anarhopus sydneyensis* by Compere and Flanders (1934), a similar condition prevails in that species.

Some larvae retain the eggshell at their posterior extremities. It more or less caps the tail of those that are caudate in form. *Leptomastidea abnormis* thus retains the eggshell during most of the first stadium. A similar condition is said to prevail in *Carabunia myersi, Cheiloneurus inimicus*, *Comperiella bifasciata, C. unifasciata,* and *Chrysopophagus compressicornis.* In these species the succeeding cast skins become telescoped with the shell during ensuing stages. In two known records, spherical larvae remained partly enclosed. Clancy's [unpublished manuscript] record of *Isodromus iceryae,* and Silvestri's (1919) of *Metaphycus melanostomatus.* It is worthy of note that in each the egg is attached by the stalk to the integument and the larva is suspended, just as in species with metapneustic tracheal systems. The larva of *Isodromus* is readily dislodged from attachment.

TRACHEAL SYSTEM OPEN

Larvae of this group are unique in Hymenoptera. As in those with closed systems, the tracheae make a complete circuit of the body, but the lateral tracheae extend posteriorly beyond the commissure and bear spiracles. Such larvae are said to have a metapneustic tracheal system as opposed to an apneustic system (lacking spiracles).

The caliber of the tracheae is often greater than in the closed systems and the circuit is always complete. The spiracles are always directly opposed to the aeroscopic plate. The posterior segments are enclosed by eggshell which becomes augmented by the exuviae. Silvestri (1919) called the resultant envelope the "respiratory hood." This hood may become filled with gas and the spiracles may be placed within the bubble instead of flush on the band.

The spiracles may be so firmly attached to the band that larvae cannot be removed intact. The typical position of the larva is in longitudinal suspension relative to the eggshell. The shell which encases the posterior end quite possibly assists in maintaining the spiracles in position. This, however, does not provide a sufficient explanation. Spiracles might be held either by suction or by some other mechanism. In later instars of some species, spiracles appear to be provided with minute finger-like projections. It has been suggested that these function as wedges in the cells of the band; however, no appendages could be detected on the spiracles on newly hatched larvae. Some larvae are easily dislodged; more particularly those that have a spherical body, as for example, *Erythraphycus argyrocomus* and *Isodromus niger*. The shape of these species is such that the shell cannot aid in holding the larva in place.

There are a few exceptions in the structure of the tracheal system and position of the larva as described above. The respiratory arrangement of a metapneustic tracheal system as heretofore observed in first instar larvae has been characterized by two open spiracles at the posterior end. The larva of *Erythraphycus argyrocomus,* however, has four spiracles (fig. 39) and these, instead of being placed crosswise to the aeroscopic plate at the distal end of the egg body, are in a row lengthwise. A single larva of an unidentified parasite, probably *Metaphycus* sp., on soft brown scale (*Coccus hesperidum*), was observed to have two pairs of spiracles.[5]

The position assumed by the larva of two species in relation to the egg shell is of great interest. The larvae of both *Aenasius maplei* (fig. 1) and *Anagyrus putonophilus* (fig. 6) hatch anteroventrally from the egg, so that they lie almost at right angles to the longitudinal axis. The spiracles, consequently, are appressed to the plate near the apex of the egg proper. Such a position may be common with larvae of other species, but has not been heretofore reported.

Most larvae are more or less sausage-shaped. The larvae ot *Erythraphycus argyrocomus* and *Isodromus niger* are spherical. Although some taper slightly posteriorly, they are always bluntly rounded. The species of *Encyrtus* have been said to have bifurcate tails, but these are lacking in *Encyrtus fuliginosus* (fig. 30, *D* and *E*), at least in the first instar.

TAXONOMIC SIGNIFICANCE OF OPEN AND CLOSED TYPES OF TRACHEAL SYSTEM

The classification of larvae according to the structure of the tracheal system may have some bearing on taxonomy. Both types, however, are found in the genus *Isodromus*. Since the tracheal system has few variations, and since larval differences may exist in other structures, the type of system is, at most, of secondary importance.

OBSERVATIONS ON EMBRYONIC DEVELOPMENT

In the discussion of technique it was stated that, in order to secure the newly hatched larva, a series of hosts were parasitized and dissected at intervals. Consequently observations were made on the development of the embryo. One

[5] [Several species of *Metaphycus* including *M. lounsburyi* have recently been found by Flanders to have four spiracles in the first instar. Flanders (1942) states that possession of four spiracles seems to be characteristic of the genus. S.E.F.]

of the phases which will be described in detail here concerns the period between maturing of the embryo and eclosion and has a bearing, direct or indirect, on the problem of larval respiration.

At deposition the egg is filled with a granulated translucent mass which gradually becomes smaller, assuming a position central to the latitudinal axis but nearer the posterior than the anterior end. The embryonic layers form at the periphery of the yolk mass. The yolk is enclosed within the embryonic mid-gut and the entire egg proper is occupied by the embryo. The indentation of the stomadeum indicates that encyrtid embryos develop with their heads in the anterior position and that blastokinesis does not take place. In all of twelve species examined the stomadeal indentations were at the stalk end of the eggs.

Following the acquisition of form, peristaltic movement of the mid-gut commences and the tracheal system appears. The tracheal trunks are the first to become visible, then the commissures and cephalic branches, and finally the lateral branches of the trunks. All those with spiracles have the trunks, commissures, cephalic branches, and most of the secondary trachea filled with gas. The number and situation of the minute secondary tracheae that appear at this time vary among species and the individuals of a species. Only rarely does an entire tracheal system become visible in the mature embryo among those species not destined to have spiracles in the first instar. With many embryos a complete loop and cephalic branches are seen, but no lateral branches. In *Apoanagyrus californicus* only a portion of the trunks are ever visible, and in *Leptomastidea abnormis* tracheae were not observed prior to eclosion. No tracheal system was found in *Pseudaphycus angelicus,* either before or after eclosion.

By the time the embryo is mature and begins to concern itself with eclosion its actions are diverse. Embryos with spiracles which are to lie near the stalk end must reverse their position. This change is accomplished before eclosion. The embryos of four species, namely *Ooencyrtus johnsoni, O. californicus, Microterys flavus,* and *Erythraphycus argyrocomus,* have been found to lie first with the head at the anterior end of the egg and then with the head at the posterior end without rupturing the eggshell. The actual process was observed twice, with different species. The mature embryo of *Microterys* turned without difficulty in a few minutes. The movement was parallel to the band and counterclockwise to the dorsum of the egg. Midway in its rotation it briefly halted. The act with *Erythraphycus* was somewhat different. The larva writhed and squirmed for some time, then finally rotated at right angles to the band with the head farthest removed from the band. Regardless of the method of reversal, it would seem that all embryos rotate that are to lie eventually with the spiracles at the stalk end of the egg. *Aenasius maplei* and *Anagyrus putonophilus,* whose larvae have the spiracles situated at the opposite end, do not alter their position.

One would expect that those lacking spiracles would not reverse within the eggshell. This is believed to be true for the majority of species, but not for all. I found one exception, *Leptomastidea abnormis.* Figure 36 shows a sequence

of embryonic stages in which it will be noted that the foregut lies anteriorly in the egg at first but before eclosion assumes the posterior position. The act of rotation was not observed. It is noteworthy that the egg has a "piece of band," that is, a few cells on the stalk, but no band on the egg proper. This may indicate that the egg and larva are transition forms between unbanded eggs and apneustic larvae on the one hand, and banded eggs and metapneustic larvae on the other.

Reversal is not necessarily embryonic movement. Though eclosion has not taken place when it occurs, embryonic development is most certainly complete; the organism therefore may be considered to be in its first larval stage.

Complete eclosion was never observed. With some species the eggs seem to cleave evenly and always along the same line. With others the eggshells seem to have fairly burst so that the shell forms a crumpled mass about the posterior segments of the larva. In *Pseudaphycus angelicus* and *Melanaphycus fumipennis* eclosion appears to be a secondary process. At some period the egg becomes detached from the stalk. The larva is enabled to feed through the resulting aperture and the consequent expansion presumably bursts the enclosing shell. The embryo of a number of species, namely, *Aphidencyrtus aphidivorus, Cheiloneurus noxius, Cheiloneurus inimicus, Chrysopophagus compressicornis, Zarhopalus corvinus,* lies coiled within the shell and eclosion has been said to occur when the embryo unflexes the tail and ruptures the chorion.

Morphology of Banded Eggs

Eggs as stated previously are arbitrarily divided into three types, banded, unbanded, and intermediate, according to the structure of the shell. Unbanded eggs have a thin elastic chorion which is extremely fragile throughout. In the intermediate type the egg proper is more firm and less likely to be damaged during dissections. In general, the eggs of these two groups have a simple unmodified chorion. The banded eggs, however, have more or less complex chorions because of structural modifications which appear to play a role in conveying the air to the developing larvae.

Eggs in Toto

As in the other groups, the shells of the banded eggs are elastic. These eggs, however, can be manipulated considerably without rending the chorion. When the entire egg is compressed, the bulb and the unbanded portions expand, the band remaining unaffected. The neck is flexible though somewhat brittle. The rigidity of the band on the egg proper assists in retaining the shell about the posterior extremity of the newly hatched larva.

In appearance the band is like a section of a cobblestone pavement, a bit of mosaic, or a cross section of a plant root. A change in focus of the microscope may bring about a resemblance to stippling. Silvestri (1919) described the bands as dimpled or reticulated, which would indicate that the areas are merely surface sculpturings of some sort. It appears, however, that the band is a highly modified portion of the eggshell. In the lateral aspect a band is seen to have thickness and to be partitioned at regular intervals into compart-

ments or cells. It is demonstrable in a deposited egg that a band is composed of tiny compartments. In a mounting medium such as glycerine, the fluid displaces the air in the bands so that gradually and irregularly the silvery sheen disappears. The action may halt for a time, then suddenly and rapidly engulf a whole group of "cobblestones." As a result of this observation and because of the similarity in appearance of all bands, the units of which they appear to be composed are called *cells* here.

It has been shown that the size and arrangement of cells form a specific pattern on the egg proper. Variations also occur in the localized thickness of cells. This is frequently noticeable in the anterior region of the neck, as, for example, in *Coccidoxenus niloticus* (fig. 22) and *Anagyrus putonophilus* (fig. 3). Less apparent are thicknesses on the egg itself. In *Coccidoxenus* and *Ooencyrtus johnsoni* cells are slightly deeper at the anterior end. There are a few notably anomalous species. In *Ooencyrtus* the species possess deeper cells at the very apex of the band. The thickness is quite abrupt and very apparent. On the neck of the egg in certain species of *Encyrtus,* namely *fuliginosus* and *infelix,* the band forms a lip which projects on one side. The lip is probably composed entirely of cells (fig. 31) although the arrangement is so complex that their interrelation is difficult to determine.

The upper and lower surface walls of the band are usually of uniform thickness throughout. However, in *Ooencyrtus johnsoni* the cells are beneath a thick wall extending over a considerable area at the anterior end of the neck, as in figures 59, *B* and *C*. Anteriorly and posteriorly the thickening disappears. In a few species there are indications that the outer wall is thin at the anterior end of the neck. Figures 3 and 22 illustrate this appearance in *Anagyrus* and *Coccidoxenus.* In both species the outer wall posteriorly for a short distance is thicker than it is anteriorly. It is quite possible that the cells at the anterior extremity of the neck are open, at least in part, and that the other cells of the band are closed.

Eggs in Section

In an effort to obtain a better picture of the true structure of bands, histological work was undertaken. Eggs of the *Anagyrus* and *Coccidoxenus* were selected, particularly because a section through the large cells at the anterior end might demonstrate whether or not any were open.

Since the egg is so small that manipulation of it is most difficult, the ovaries were sectioned. This would have the additional advantage of providing sections through several eggs at one time. Sections five microns in thickness were found to be preferable. The first preparations were made of ovaries in the normal, coiled position in the belief that the eggs would then be cut at a variety of angles, some of which would certainly supply the necessary information. The result was such a tangle of eggs and ovarian tissue that it was impossible to detect an orderly series. Thereafter, ovaries were uncoiled before being fixed in Bouin's solution.

The results of staining were decidedly unsatisfactory. The first sections were treated with eosin and haemotoxylin. All the structures with the exception of the eggshell would take this stain. If the chorion had become in the least

stained, the observations might have been successful. Basic fuchsin, acid fuchsin, borax carmine, and acid fuchsin in lactophenol were tried with appropriate modifications in the procedures. With the exception of the last named, there were no noticeable improvements. Since this one offered some promise, many experiments were undertaken to improve the effect by varying the period in the stain and destaining with alcohol, acetic acid, or water. Not one of the procedures showed much improvement with respect to the staining of the eggshell, and there was no opportunity for further experiments to obtain a reagent specific for eggshell.

Observations were therefore dependent upon the characteristic light refraction of the shell. In sections other than across the band, nothing of the structure could be detected. On the egg proper the band is so thin and the cells are so minute that its nature was not observable. The failure to stain and the minuteness of the cells are not the sole obstacles to observation. In any section the walls of other cells obstruct vision. If each cell had a minute hole in the center on the upper surface, it would not be seen even if the microtome blade should pass directly through one cell; for the surface of the cell situated directly behind would cause the appearance of a solid layer. If sections could be cut as thin as the width of one cell, it might be possible to discern the structure without interference from the walls.

The following data were derived from the only preparations which could be obtained to supplement observations of the whole mounts—those in which the sections intersected the neck at right angles in the areas of larger cells:

Anagyrus putonophilus (fig. 4, *A.*).—The shape of the band on the neck in cross section is like that of a horseshoe. Normally the shape is probably flatter, the ventral nonbanded area becoming extended. The inner wall is slightly thicker than the outer wall. The cells are closely packed together. The size and number are associated with the portion of the neck on which they occur. The number and breadth of cells are the same as that which appears on the surface when viewed in toto. In figure 4 the appearance at several points is diagrammed: *A*, *B*, and *C* are successive views of the first third of the anterior end as shown in figure 3. The definition of cell boundaries is not as clear as indicated. Upper and lower surfaces appear to be slightly thinner in the sections showing the cells farthest anterior but no opening could be detected. The interrelationship of cells could not be determined.

Coccidoxenus niloticus (fig. 23).—No clear sections of the anteriormost portions could be secured because of the curvature. The shape is probably similar to *Anagyrus*. *A* is considered typical of the portion occurring as the posterior third of the anterior end of the neck, as shown in *A* and *B* of figure 22. The size and number of cells depend upon the point of sectioning. The upper wall of each cell is slightly convex. Descending the stalk (*B* and *C*) cells are broader and fewer. On the greater part of the neck there are only four large cells and they appear to be continuous to form tubes down the neck. Just in front of the egg proper (*E*) the cells are more variable in number and size. Posteriorly they then become so small in both dimensions that the structure disappears.

The data given is far too poor for a complete understanding of the composition of bands. There is no clue to the manner of ingress or passage of air. Adjacent cross sections may have a variable number of cells without any suggestion of interconnections. However, because of the general appearance of bands and the behavior of liquids passing within, there is undoubtedly some sort of connecting system.

PHYSIOLOGY OF RESPIRATION

It has been generally believed that endoparasitic larvae without spiracles and those devoid of tracheae obtain their oxygen by way of osmosis, either through the body surface or the intestine. This theory seems adequate for all larvae with closed tracheal systems. Internal parasites that respire atmospheric air are, however, very rare and encyrtids are the only known *Hymenoptera* equipped with posterior spiracles for this purpose. I have confined my studies largely to those encyrtid larvae having metapneustic tracheal systems.

The prevalent explanation of the manner in which the larvae respire is attributable to Howard and Fiske (1911), who held that the stalk of the egg of *Ooencyrtus kuvanae* was hollow and conveyed air to the larva "like a life line attached to a submarine diver." No respiratory system was described. Imms (1918) found that the young larva of *Blastothrix sericea* possessed tracheae with two spiracles situated at the caudal extremity of the body and concluded that it could thereby breathe directly through the egg stalk. The conception that encyrtid larvae with metapneustic tracheal systems respire atmospheric air by way of the hollow egg stalk has persisted up to the present time.

Three observations of Silvestri (1919) on certain species should have altered this concept: (1) the eggshell was very complex in structure; (2) air appeared in the band on the deposited egg from the anterior end of the neck on to the egg proper; (3) the spiracles of the primary larva adhered to that portion of the shell bearing the band. His opinion regarding the manner of respiration was to the effect that the projecting anterior end of the stalk was a sort of porous stopper ("respiratory plug") which permitted the osmotic passage of atmospheric air; the lumen of the petiole or neck functioned like a tracheal tube; the reticulations on the egg proper served as an "aeroscopic membrane" (the exact role played by this structure was not made clear); eggs possessing this structure he called "tracheated eggs." Presumably Silvestri believed that the "plug" provided the means for air to enter the lumen of the neck, which conveyed air to the spiracles of the larva. Consequently his opinion differs from that of other observers only in the manner in which air enters the stalk, the others having maintained that entrance was gained by the open apex of the broken stalk.

My hypothesis, based on observations almost identical with Silvestri's, was that atmospheric air penetrates and pervades the band on the egg but does not enter the lumen of the stalk, the larva obtaining the air directly from the band. To determine the validity of this contention recourse was had chiefly to the dissection of live hosts of many species.

Evidence That the Band Conducts Atmospheric Air

STRUCTURAL CORRELATION BETWEEN THE EGG AND LARVA

A remarkable and significant correlation exists between the structure of an egg's shell and the tracheal system of the larva developing in that egg. The classification of the egg and first stage larva as used herein is based on this correlation.

Larvae hatching from eggs of the unbanded type have, so far as known, a closed respiratory system. An egg of this structure is deposited free or attached to organs but no part is attached to the host's derm or shell. Likewise there are no air-bearing structures. Consequently neither the position nor the structure of the egg provides a means for the passage of atmospheric air.

Larvae from eggs of the intermediate type likewise have a closed respiratory system. An egg of this type is suspended within the host by the neck which passes through the integument. Only in *Ectromatopsis americana* were there air-bearing structures; and in it the air scarcely reached beyond the neck of the egg. The larva of *Ectromatopsis* as with other larvae from eggs of the intermediate type (excepting *Clausenia* and *Bothriothorax*, which were not obtained for study) has an apneustic tracheal system.

In my observations, all larvae with caudal spiracles developed in banded eggs. It may be erroneous, however, to state that only larvae with metapneustic tracheal systems develop in eggs of the banded type. The egg of *Metaphycus melanostomatus* was illustrated by Silvestri as bearing a band (fig. 48) though a description was omitted and the larva (fig. 49) was figured without spiracles. In my opinion additional exceptions may be found to occur. The converse, that larvae with metapneustic tracheal systems hatch only from eggs with bands, appears true although the evidence is scant; however, I observed the correlation with fifteen species. To these can be added four species reported by Silvestri. Other investigators have described or illustrated at least four other species in which such correlation seems very probable.

OCCURRENCE OF AIR WITHIN THE BAND

Air contained in any transparent object immersed in a clear fluid has a typical appearance; it is white or silvery color by reflected light, and gray or black by transmitted light. Banded eggs exhibit this appearance immediately after being deposited. Silvestri was the only one to have stated that air occurs in the band; but of the four banded eggs he described he mentions this fact for only two species, *Encyrtus infidus* and *Phaenodiscus aeneus*. Other investigators probably observed the effect but did not recognize the cause or significance. Smith and Compere (1920) stated that the stalk of the egg of *Metaphycus lounsburyi* became dense white immediately after oviposition. A waxy incrustation was reported to occur on the egg of *Encyrtus infidus* by Clausen (1932).

I examined the deposited eggs of twenty-three species. Of the eighteen that were banded, the color effect appeared only in the band on the neck and egg

proper. Nonbanded eggs were entirely translucent. Silvestri stated that in *Phaenodiscus aeneus* air was present the length of the petiole and in the band on the egg proper. Evidently he did not note that air was confined entirely to the band on the petiole; for he, like others, indicated that the lumen of the stalk itself conveyed air.

APEX OF THE STALK

With the exception of Silvestri, writers have stated or implied that air entered by the open apex of the petiole. Silvestri observed the petiole to be capped by the remains of the bulb. I found, in all but one of the species examined, that normally the bulb was simply shriveled and collapsed.

That the bulb may be perfectly intact was demonstrated as described above. Eggs were dissected free from the host as soon as possible after their deposition. They were mounted in Hoyer's solution and very carefully compressed under a cover glass. The procedure was attempted with the eggs of *Encyrtus infelix, Ooencyrtus johnsoni,* and *Anagyrus putonophilus.* With noticeable pressure, material could be forced back into the bulbs of the eggs of *Encyrtus* and *Anagyrus,* which again inflated. Undoubtedly the plug which later appears within the stalk begins to form immediately after deposition of the egg, and it is this that necessitates the undue pressure. Figure 5, *A,* shows a deposited egg of the *Anagyrus* after it has undergone this treatment. No difficulty was encountered in inflating the bulb of the *Ooencyrtus* egg. This effect indicates that, with these species at least, the bulb is not destroyed during oviposition.

Damaged bulbs have been observed, and in *Encyrtus fuliginosus* the bulbs were almost always missing. In any case the bulb may eventually deteriorate so much that the stalk becomes open at the apex. The fact remains, however, that in the great majority of species the stalk is closed at the end.

BLOCKED LUMEN OF STALK

With some eggs a plug occurs in the lumen of the stalk immediately in front of the egg proper. Embleton (1904) reported this "protoplasmic matter" in the ovarian eggs of *Encyrtus infelix* and Thorpe (1936) frequently found the plug in the same species. I have observed plugs in a number of other species. The period of plug formation is variable but never occurs until after deposition of the eggs. It appears in *Anagyrus putonophilus* soon after the egg is deposited, but not in *Aenasius maplei* until after eclosion. *Encyrtus infelix* was extensively investigated but no plug such as was noted by Embleton was found in the neck of the ovarian egg. It appeared, however, soon after deposition.

With the *Encyrtus* (fig. 33), the *Anagyrus* (fig. 5, *B*), *Aenasius maplei* (fig. 1, *B*), and *Leptomastix dactylopii* plugs are black and opaque. With *Metaphycus howardi* (fig. 45) the plug is brown and somewhat transparent. All plugs are solid and do not break up when compressed under a cover glass. Thorpe (1936) thought that the plug in the *Encyrtus* only partly blocked the stalk and could not prevent the passage of air. However, if air penetrated the hollow stalk, the color would change both above and below the plug. In none

of the eggs of the above species, or of those eggs of other species without plugs, was the silvery appearance observed within the lumen of the stalk.

The origin of plugs is problematical. Thorpe regarded them as remnants of the apical yolk mass. I believe they may be derived from the vitelline membrane that was contained within the bulb. Though eggs of some species have some sort of crumpled material within the stalk, the deposited eggs of most species lack even this bit of extraneous matter, even though members of the same genus possess plugs. In *Encyrtus fuliginosus* and *Erythaphycus argyrocomus* the stalk appears unobstructed.

LOCATION OF SPIRACLES

Most investigators in discussing the tracheal systems have indicated that the spiracles of the primary larva are at or near the opening of the stalk into the egg proper. In my observation the spiracles appear located on the inner surface of the aeroscopic plate on the egg proper. With a few notable exceptions, they are attached a short distance from the neck. Silvestri stated that in *Phaenodiscus aeneus* and *Encyrtus infidus* the spiracles adhere in a similar position. This appears in the illustration of the former species, but in that of the latter the spiracles are unattached (see figs. 16 and 34). Thorpe has described and figured the same sort of arrangement with *Encyrtus infelix*. Neither Silvestri nor Thorpe ascribed any significance to their findings.

The position of the spiracles in three selected species is unique and offers strong evidence in support of the respiratory function of the band. The larvae of *Anagyrus putonophilus* and *Aenasius maplei* have the spiracles at the end of the egg opposite the stalk; in fact almost at the posterior apex (figs. 6 and 1, respectively). The *Erythaphycus argyrocomus* larva places its four spiracles parallel to the length of the band (fig. 39) and not crosswise as is the usual position.

In all the specimens examined the situation of the spiracles appears so remote from the stalk that it would appear impossible for them to secure air from its lumen.

COURSE OF STAINED OILS

By immersing the entire host in "a thin vegetable oil" which had been strongly stained with a dye "such as Sudan III," Thorpe endeavored to demonstrate that the first instar larva of *Encyrtus infelix* was enabled to utilize atmospheric air by means of the stalk. He states that the colored oil speedily entered the egg stalk and invaded the tracheal system of the larva. I sought to duplicate this experiment and encountered difficulty in securing an oil that not only would penetrate rapidly but also could be stained dark enough to be detected easily in the minute structures. Sundry vegetable oils failed to penetrate and it was evident that a much lighter oil was necessary. Clove oil or a 50 :50 combination of xylene and kerosene was finally selected. Neither xylene nor kerosene was suitable by itself. Xylene would not penetrate in less than four minutes and distorted the material by dissolving the fats. Kerosene could not be stained dark enough. The stain selected was Oil Red O (Sudan II), which colored the oils darker than either Sudan III or IV.

This method was used with three species, namely *Ooencyrtus johnsoni*, *Encyrtus infelix*, and *Anagyrus putonophilus*. The procedure was to immerse the parasitized host from one to five minutes. After immersion the oil was sponged from the surface and the host dissected in normal salt solution. If any oil was observable within a host, that host was discarded; but if none had penetrated, the eggs or larvae were carefully removed intact and observed unmounted. Those in which any stain was observable were then mounted in normal salt solution of glycerine. If the neck and the bulb of the egg were damaged, the specimen was likewise discarded since there was no certainty that the stalk had not been broken prior to or during the immersion and consequently had permitted the oil to enter the lumen of the stalk.

With *Oencyrtus* the brilliant red color was visible within the plate. The band on the egg proper was penetrated to the very end. Owing to the melanization of the band on the petiole, no color was observable there; nor was oil found in the bulb, the lumen of the stalk, or the egg. During one-minute immersions only the cells on the outer margins of the plate on the egg proper were filled. After a longer period the oil entered the center section and the stain in that area was darker. The larval tracheal system also was invaded, for a pink color was seen within the trunks and commissures. In some specimens the silvery appearance remained in the band and the tracheal system even though other specimens within the same individual host had been thoroughly penetrated. For this there seems no plausible explanation.

Similar results were obtained with the other species. In *Encyrtus* no oil entered the bulb. Whether any had entered the lumen of the stalk was not ascertainable because of the abbreviated neck, the slight melanization of that portion within the host, and the minuteness of the band. It was obvious, however, that no oil had penetrated beyond the plug except within the plate and thence into the tracheal system of the larva. In *Anagyrus* the color was seen in the band but not in the tracheae. However, since light was no longer refracted by the tracheae, there was no doubt that the oil had entered.

The experiment was performed with *Anagyrus* larvae free of the host. The larva was placed in a thin film of normal salt solution, a cover glass was supported over the larva by bits of modeling clay, and the cover slip was gently slid and the larva so placed that its entire body and the lower part of the egg shell remained in the solution while the stalk projected free. A minute drop of the stained oil was then placed at the tip of the stalk. The result was the almost immediate elimination of air in all the structures of the egg and larva. Color could be discerned in the band and the posterior section of the tracheal trunks. If any oil had entered the stalk its presence in the lumen would have been obvious.

These results are directly opposed to those obtained by Thorpe.

Means Whereby Atmospheric Air May Enter and Leave the Band

The one factor all theories have had in common is that the hollow stalk served to convey air. Most investigators have maintained that the apex of the stalk was open or became open. It has been shown that with most species the neck is

capped by the collapsed bulb and that air cannot, normally at least, freely enter the lumen of the stalk. Even if the chorion at the anterior end were not intact or entrance was gained by osmosis, air could easily be detected. At no time have I observed air within the egg stalk.

All workers, with the exception of Silvestri, have failed to observe the complex structure of the eggshell, which offers a very important clue to another means whereby atmospheric air could be conveyed; careful observations of the deposited egg might have shown that air was contained within this structure. Obviously Silvestri (1919) was remarkably close to a more adequate explanation, but his interpretation of function is unduly complicated and incomplete. Silvestri's theory is essentially that air passed by osmosis to the cavity of the petiole, and the petiole functioned in the manner of a trachea. In my opinion, Silvestri did not realize the role of the shell structure. Although the spiracles of the first instar larvae of two species were said to adhere to the dorsal part of the eggshell, in only one species were the spiracles illustrated as adherent to the plate. If the plate had been considered to be of respiratory significance, the tracheae of all four metapneustic larva would undoubtedly have been drawn or at least explained, as leading to the plates.

Considering the observations and experimental evidence, I believe there is little reason to doubt that the band or plate on the egg provides these larvae with the means to respire atmospheric air. It may well be asked, "How does air get into the plate?" While it is in the ovaries, the egg does not have a silvery sheen in the banded areas; but immediately after its deposition the sheen is usually prominent. If the assumption is correct that this sheen is due to air, the air must have entered at the moment of deposition. On the basis of the information at hand, it is possible to make a few suppositions. In passing down the ovipositor the eggs are greatly compressed. The internal structure of the plate is in the nature of a sponge which is emptied of any fluids by this compression. As the egg is deposited, the "sponge" swells because of the elasticity of the cells. The surface of the plate is impervious to the fluids of the host and therefore a vacuum exists. When the end of the stalk leaves the ovipositor, air rushes in and disperses throughout the structure. This would imply that the cells are open to the atmosphere at the extreme end of the stalk only. It has been pointed out above that there is a suggestion of an opening at this point, but this could not be confirmed by sectioning. I am forced to assume that the structure of the anteriormost portion is such as to permit the entrance of air at that point only. Osmosis may operate as Silvestri suggested, but certainly it does not carry air into the lumen of stalk as Silvestri apparently believed.

The manner in which air is withdrawn from the aeroscopic plate is also obscure. No openings appear through which air could be directly removed. In later instars, some spiracles bore finger-like projections. It is possible that these are glands the secretion from which dissolves away the cell walls permitting the attachment of the spiracles, and thus providing a direct passage for air. No such processes could be found on the spiracles of first instar larvae. I am inclined to believe that air passes solely by osmosis.

Before any definite theory may be advanced concerning the physical phenomena involved in the ingress and mode of exit of atmospheric air, the morphology of the aeroscopic plate obviously must be better understood.

NEED OF ATMOSPHERIC RESPIRATION

The need for atmospheric air has not yet been conclusively demonstrated. If, however, the free flow of air into the stalk were prevented and the parasite died, it should indicate that atmospheric air was necessary for the development of the egg or larva.

To test this hypothesis, nearly mature black scale (*Saissetia oleae*) which had been exposed for two days to the females of *Microterys saissetiae* were selected for two simultaneous experiments. In one, twenty stalks were covered with Vaseline and ten were left undisturbed; in the other, melted paraffin was dropped on twelve stalks and four were retained as checks. In each host there was a maximum of three receiving the treatments and at least one check. At experimental temperatures ranging between 75° and 80° F, eclosion occurred in two days, and dissections were made after four days. The vaselined eggs either failed to hatch or the young larvae died; some unhatched eggs contained little or no air in the band. From the uncovered stalks, normal fourth instar larvae were suspended. The results of the second experiment were identical except that air remained within the bands.

Two outstanding faults in the experiments are recognized. First, the methods alone may have killed the developing parasite; some fluid constituent of Vaseline may have penetrated and killed the egg, thus explaining the absence of air, or the temperature of the paraffin may have been damaging. Second, few data were obtained. Nevertheless, the results indicate that atmospheric air is inducted by way of the stalk and is necessary for the development of the egg and larva of *Microterys saissetiae*.

The variability of the oxygen requirements among encyrtid larvae is scarcely open to question because of the structural variability exhibited by the tracheal system.

[The fact, as stated above, that the development of embryos in eggs attached to the host's integument is more rapid than with embryos in eggs unattached to the host's integument suggests that the rate of development is influenced by additional oxygen obtained through the respiratory band. S.E.F.]

The larva of *Coccidoxenus niloticus* has tubes of large diameter compared with other species, such as *Anicetus annulatus*. Among the apneustic larvae there are those in which only a portion of the tracheae appear before eclosion as opposed to those in which complete loop is visible. *Tetracnemus pretiosus* and *Anarhopus sydneyensis* are said to have "rudimentary" tracheae late in the first period. Then there are primary larvae in which no tracheae can be seen at all.

Metapneustic larvae are in a position to obtain oxygen by the same means as those without spiracles or those lacking tracheae. Osmosis may operate but perhaps not to the same degree, depending upon the character of the parasite integument. The fragility of larvae is noticeably variable. As a rule apneustic

larvae are easily damaged and must be carefully handled. The metapneustic larvae of most species can stand rough treatment. Since those with weaker integument may obtain oxygen more easily by osmosis than those that are sturdier, the amount of oxygen taken in by way of the stalk may be in inverse proportion to that obtained by osmosis.

Respiratory needs may be temporarily fulfilled by the host. In dissection of eggs of the squash bug, *Anasa tristis,* several stalks of the eggs of *Ooencyrtus californicus* were noted to have broken off. Instead of there being one parasite egg present, as indicated by the projecting stalk, there were two or three (fig. 58). Very rarely, a stalk became detached so that the larva was floating within the host. It is certain that the attachment had not been broken during dissection, for the larva appeared to be perfectly normal. Sufficient oxygen was no doubt obtained without direct connection with the outside air. Whether this larva would mature or not is a matter of conjecture, for the requirements may be greater in later instars.

This need is also indicated by the fact that the tracheal system of the mature embryo may contain oxygen obtained by osmosis. It was observed repeatedly with embryos possessing spiracles that all or nearly all tracheae, including the fine branches, were discernible without the spiracles' being near the aeroscopic plate. Often the spiracles were at the farthest possible point from the plate.

The band itself could conceivably function as an osmotic surface. A considerable area is exposed to the host's contents and osmosis may occur through that portion of the shell as well as through the parasite integument, and perhaps with greater ease.

Atmospheric air is carried within the eggshell, which is structurally modified to convey it. The lumen of the stalk cannot conceivably play this role and furthermore does not function in this manner, as heretofore supposed. All larvae with open tracheal systems hatch from eggs with air-bearing areas on the shells and place their spiracles against these areas. Although they have the means to breathe air which is outside of the host, many if not most species may be independent of atmospheric air in the early instars.[6]

DESCRIPTION OF EGGS AND FIRST INSTAR LARVAE OF CERTAIN ENCYRTIDS

The following pages discuss the eggs and first instar larvae of all encyrtids, with the exception of the polyembryonic species, which I have observed or which are described in published or unpublished papers. I have drawn freely upon the literature. In many papers, authors' statements or figures indicate that observations were incomplete or inaccurate. The significance of some findings was, in my opinion, overlooked.

Descriptions are largely confined to the egg and the larval respiratory structures. My other observations, though perhaps of biological interest, are inci-

[6] [After Maple had completed his studies on the Encyrtidae, DeBach (1939) demonstrated the existence of an encyrtid which is not endoparasitic. This unique species, *Microterys titiani* Gir., deposits from 1 to 10 eggs *beneath* its host, *Lecanium corni* Bouché. The stalk of a deposited egg comprises about one-half the egg in length. The first instar larva is hymenopteriform and possesses a peripneustic tracheal system. S.E.F.]

dental to the problem. Adequate references to the published records are provided throughout, should further information be desired.

The drawings are largely mine. Originals by Harold Compere and D. W. Clancy were kindly lent to me. Some were copied from other publications, if other authors' observations could thereby be better demonstrated. The sketches of larvae are diagrammatic. Needless detail is left out and only half of the tracheal system is shown in the lateral views, thus confusion should be eliminated without causing undue simplification.

The dimensions given are measurements of single eggs; where an egg is illustrated, its dimension is given.

The arrangement is alphabetical, according to genus.

Acerophagus fasciipennis Timb.

Only the ovarian egg of the parasite was examined, and it was extremely simple (fig. 62, *B*). The entire egg is flexible and in no two mounted specimens was the shape the same. In all specimens the neck and bulb were twisted and partly collapsed. The neck is long, narrow, and undifferentiated from the bulb. The length of the two measured was 0.112 mm., and the widest portion was at the distal end. The egg proper measured 0.06 mm. by 0.03 mm. It was widest at the proximal end. In outline it was more nearly angular than rounded. There was no band.

The egg is probably deposited entirely within the host and the newly hatched larva would doubtless not possess a metapneustic tracheal system.

Acerophagus notativentris (Gir.)

The egg of this species was described by Clausen (1924) and appears to be quite similar to that of the preceding species. Eggs that I observed had the outline shape of a teaspoon, the neck and bulb being the handle. The measurements of a typical egg were: length of bulb and neck, 0.128 mm.; widest portion of bulb, 0.017 mm.; length of egg, 0.07 mm.; width of egg, 0.034 mm.

According to Clausen, during the process of oviposition the contents of the smaller body are forced into the egg proper, though the collapsed membrane remains attached; the egg lies free within the host. He did not indicate the type of larval respiratory system. The egg provides no means for securing atmospheric air should the larva possess spiracles.

Acerophagus pallidus Timb.

An extensive study of the parasite was not made although this species is frequently obtained from native mealybugs in southern California, as well as from the introduced species, *Phenacoccus gossypii* Twns. and Ckll.

The ovarian egg (fig. 62, *A*) has no distinctive features and differs in no essential structural detail from the other species of *Acerophagus* discussed. The neck is short and undifferentiated from the bulb, which is long and narrow compared to the remainder of the egg. The measurements were: length of bulb, 0.188 mm.; maximum width of bulb, 0.034 mm.; length of egg, 0.086 mm.; width of egg, 0.06 mm.

The deposited egg and the larva were not examined; nevertheless, there is little doubt that the egg is laid entirely within the host and that the newly hatched larva is without spiracles.

Achrysopophagus modestus Timb.

The early stages of this secondary parasite, when reared on *Zarhopalus corvinus* (Girault) and *Anagyrus subalbicornis* (Girault), appear to be similar to those of *Chrysopophagus* and *Cheiloneurus*. Clausen (1924) found that

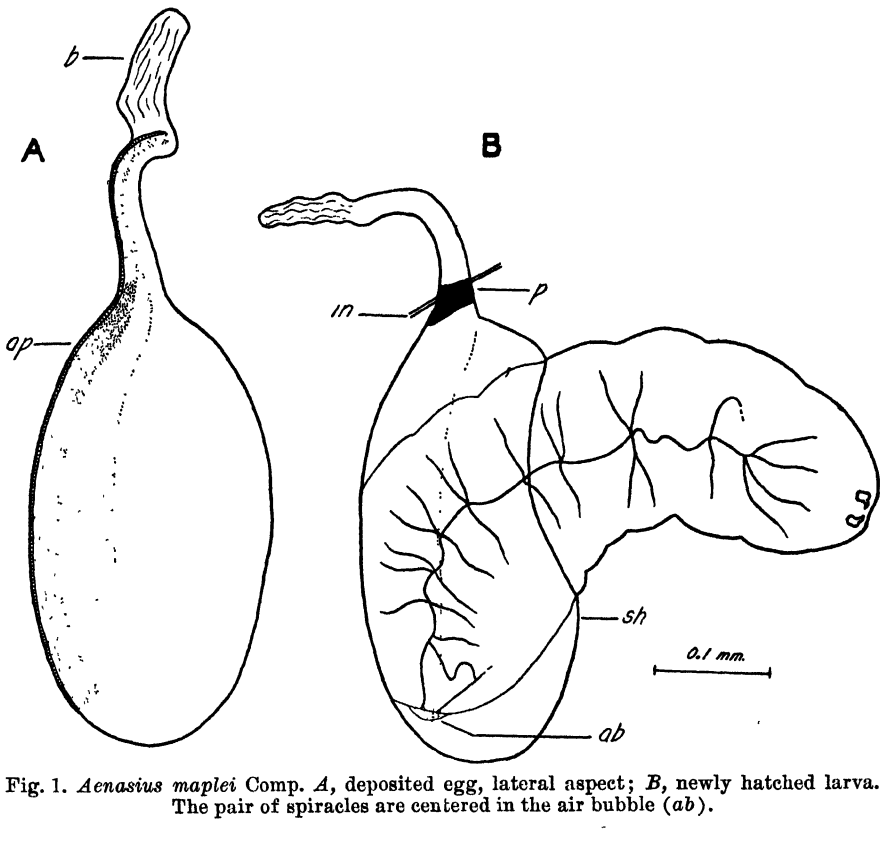

Fig. 1. *Aenasius maplei* Comp. *A*, deposited egg, lateral aspect; *B*, newly hatched larva. The pair of spiracles are centered in the air bubble (*ab*).

the egg floated free within the host's body, the collapsed bulb remaining attached. The larva was noted to be of the tailed type. Although Clausen does not say so, it would necessarily follow that the tracheal system is apneustic.

Aenasius maplei Comp.

An extensive search was conducted for sufficient material with which to study the development of this species. Although its mealybug host, *Puto yuccae* Coq., is abundant, the parasite is exceedingly rare. The following information was secured with the use of a single female.

Deposited egg.—The egg is of the banded type and is therefore attached to the integument of the mealybug. The anterior end of the neck is curved and

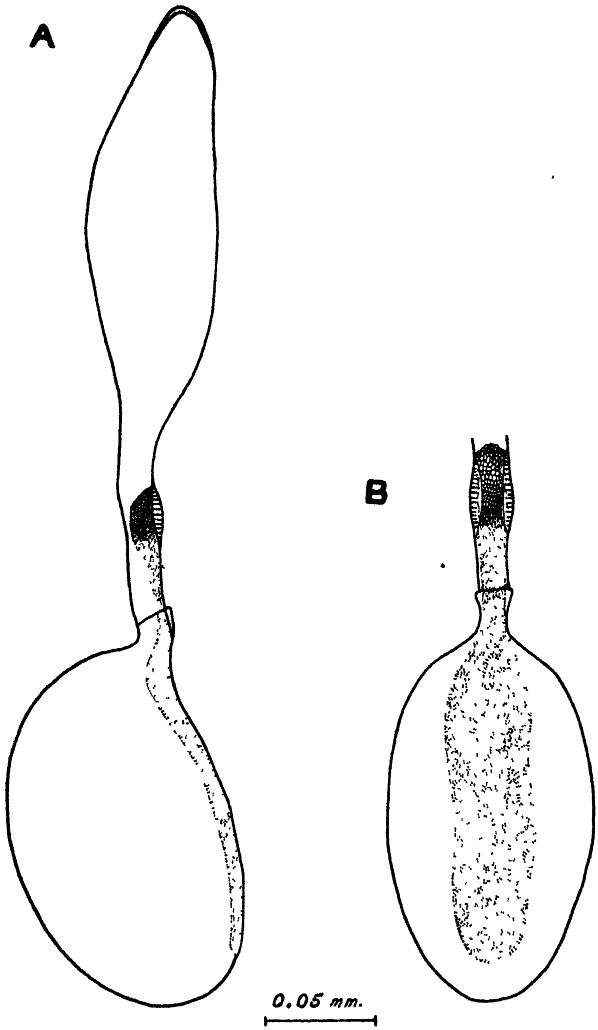

Fig. 2. *Anagyrus putonophilus* Comp. *A*, ovarian egg, lateral view; *B*, neck and egg proper, dorsal view.

this portion, together with the collapsed bulb, projects to the host's exterior. The band on the egg body is wide and long. It is widest near the stalk end and somewhat pointed at the apex. The center longitudinal section is composed of somewhat larger cells than the marginal areas. The band becomes melanized to a light brown prior to eclosion. Figure 1, *A*, shows a deposited egg with host tissue removed.

Larva.—The larva (fig. 1, *B*) is remarkably similar to that of *Anagyrus putonophilus* parasitizing the same host. The completely developed embryo does not reverse its position prior to eclosion but hatches with the head toward the stalk. The single pair of spiracles is placed at the other extreme. In the one specimen studied the spiracles were neither attached to the band nor in

opposition to it, but were placed in the center of an air bubble at the bottom of the eggshell. It is highly probable that the larva was dislodged from its normal position by dissection. In later instars the spiracles are situated midway of the band.

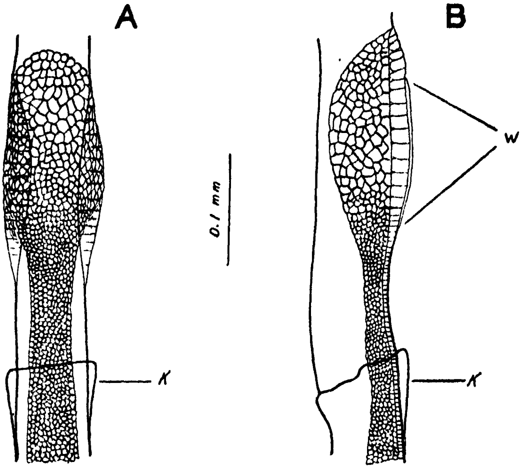

Fig. 3. *Anagyrus putonophilus* Comp. *A,* distal end of the neck of the egg, dorsal view; *B,* lateral view.

The stalk is not plugged in the manner seen in *Anagyrus putonophilus,* but a smaller, solid, and opaque plug forms by the time the second instar is reached. Melanized host material accumulates around the stalk immediately below the integument.

Anagyrus putonophilus Comp.

This encyrtid is the most abundant parasite of the mealybugs *Puto yuccae* Coq. and *P. ambigua* in southern California. The latter host has overlapping generations throughout the year and it was from this host that material was obtained for study at various times over a period of two years.

Ovarian egg.—The ovarian egg (fig. 2) of this *Anagyrus* is of the banded type. The bulb is long and narrow and possesses a slight thickening at the apex. The neck is short, and near the bulb end it is appreciably swollen. At this point the band appears, nearly circumscribing the neck. At the base of the swelling the band narrows to continue down the neck. Detailed views of the distal end of the neck are shown in figure 3.

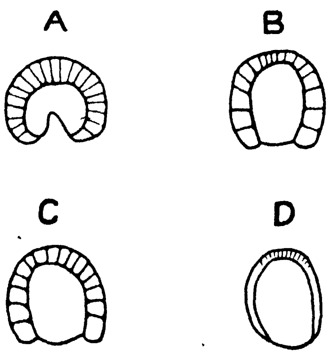

Fig. 4. *Anagyrus putonophilus* Comp. *A,* sections across the anterior of the stalk; *A, B,* and *C* in sequence in the area of large cells; *D,* posterior section, semi-diagrammatic.

Near the egg proper the neck exhibits a slight projecting lip which is a further modification of the eggshell and not a part of the band. As is true of the other somewhat similar structures, no function has been assigned to this "collar."

The band on the egg body is moderately large

and extends nearly to the apex of the egg. The margins are neither straight nor parallel. The measurements were: length of bulb, 0.21 mm.; width of bulb, 0.056 mm.; length of neck, 0.094 mm.; width of neck, 0.017 mm.; length of egg, 0.15 mm.; width of egg, 0.09 mm.; length of band, 0.133 mm.; width of band, 0.034 mm.

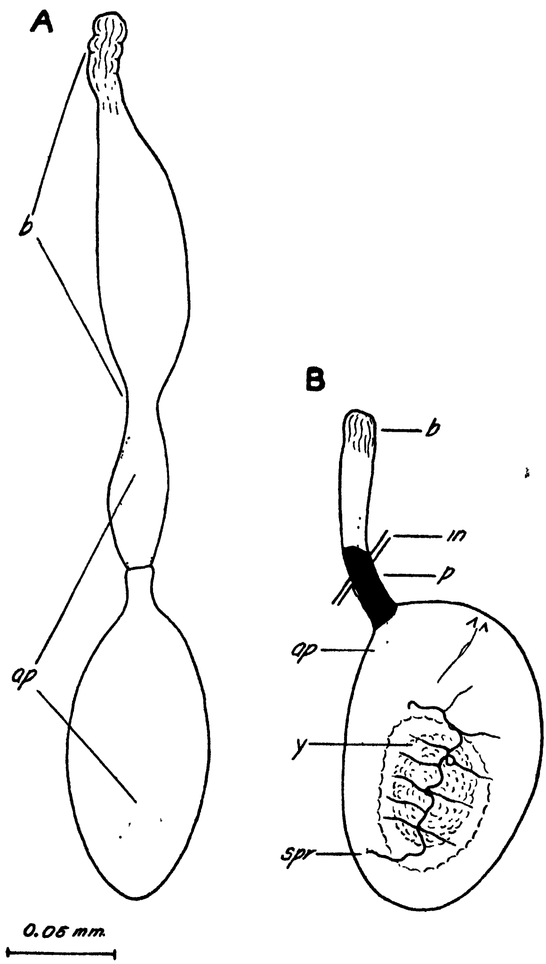

Fig. 5. *Anagyrus putonophilus* Comp. *A*, newly deposited egg after compression, showing the reinflation of the bulb; *B*, deposited egg containing fully developed embryo.

Deposited egg.—The egg is attached to the integument of the mealybug as shown in figure 5, *B*. The portion exterior remains erect. When a newly deposited freshly dissected egg was compressed, the bulb was found to be intact and could be partly reinflated (fig. 5, *A*). Complete expansion to the original size could not be obtained. A few hours after deposition a close-fitting plug forms within the neck, and the contents of the egg body cannot be forced back into the collapsed bulb. This plug becomes opaque, black, and solid before the

hatching of the larva takes place. The embryo develops with the head at the stalk end of the egg and hatches from that position.

Larva.—The larva (fig. 6) has a well-developed metapneustic tracheal system. There is a single pair of spiracles which are nearly contiguous, approximately 0.0043 mm. apart; they are attached at the posterior extremity of the band and remain in that position throughout the early larval life.

Anagyrus subalbicornis (Gir.)

Clausen (1924) has stated that the egg of this mealybug parasite differs in no essential respect from that of *Zarhopalus corvinus*. I noted, however, that

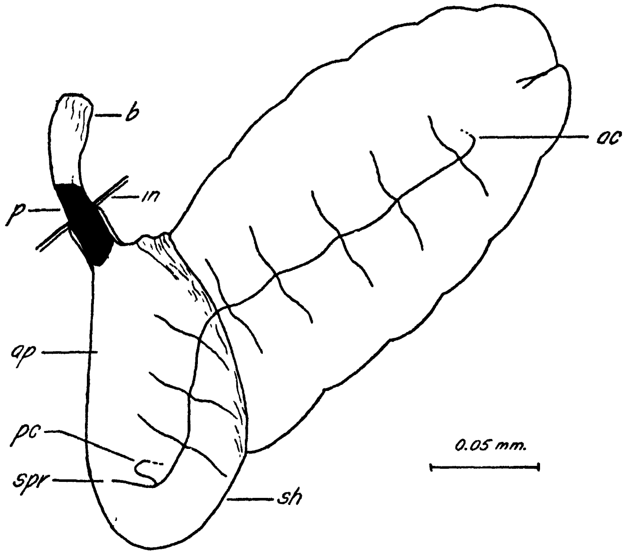

Fig. 6. *Anagyrus putonophilus* Comp. First instar larva. The spiracles are placed at the base of the aeroscopic plate (*ap*).

the egg of *Anagyrus* remains attached to the derm of the host, and the caudal end of the larva remains attached to the stalk up to the last larval stage. The egg of *Zarhopalus*, on the contrary, lay free within the host and no part of the larva remained within the eggshell.

Since the egg is attached to the integument and the larva remains partly enveloped by the eggshell up to the last stage, it may be readily assumed that the egg is banded and the larval tracheal system is metapneustic.

Anarhopus sydneyensis Timb.

Compere and Flanders (1934) found the eggs and larvae to be similar to those of *Tetracnemus pretiosus* (fig. 67); they found the deposited egg to be free in the body fluid of the host mealybug, but suggested that the usual position may be one of attachment to the integument. The minuteness of the eggs made it difficult to determine this point.

For the purposes of this discussion, the larva of *Anarhopus* is assumed to

be identical to *Tetracnemus,* i.e., in the first part of the stadia the larva is atracheate but later on it possesses rudimentary tracheae in the thoracic region.

Anicetus annulatus Timb.

Only a limited supply of material of this primary parasite of *Coccus hesperidum* Linn. was available. The egg has a neck slightly longer than the egg proper, which is narrowly elliptical and has a band no wider at any point than the neck. Compere (1924) in describing the egg omitted any reference to a band, but in his drawing of the deposited egg (fig. 7) there is a suggestion of a band.

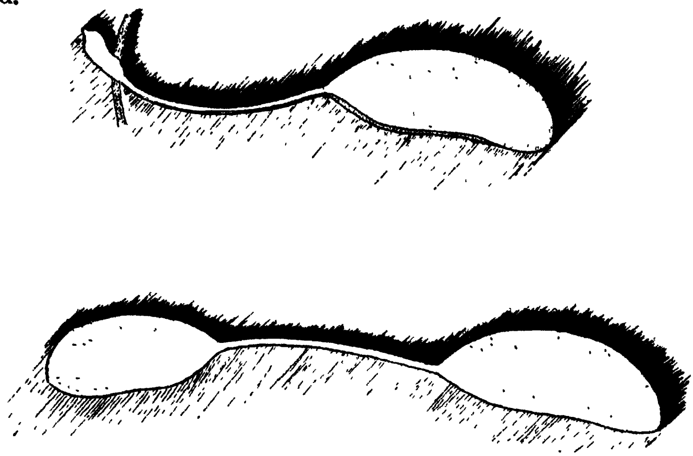

Fig. 7. *Anicetus annulatus* Timb. Upper, newly laid egg with tip of stalk projecting through the integument of the host. Note the bandlike appearance. Lower, egg before oviposition. (Drawing by Compere, 1924.)

The measurements of one egg which I observed were: length of bulb, 0.141 mm.; width of bulb, 0.056 mm.; length of neck, approximately 0.227 mm.; length of egg, 0.184 mm.; width of egg, 0.073 mm.

Compere noted that the deposited egg was suspended by the long stalk from the integument of the host, and surmised that the stalk was probably utilized in respiration of the larva but did not descrbe the tracheal system. My observations were only slightly more adequate. The neck of the deposited egg is so long that it doubles back upon itself. The bulb remains intact though collapsed. The larva develops with the head at the anterior end of the egg and reverses before eclosion, so that the single pair of spiracles lies almost at the very base of the stalk. The tracheae are comparatively minute but the system is complete.

Anisotylus sp.

Only the ovarian egg of this coccinellid parasite was examined. A description is incorporated here as none of the immature stages of any representative of the genus has been reported.

The ovarian egg (fig. 8, *A*) is exceedingly large in comparison with most encyrtid eggs. The bulb is not as long as the egg proper and the neck is shorter than either body. The egg proper is elliptical in shape, without any modifica-

tion of the chorion. The measurements were: length of bulb, 0.218 mm.; width of bulb, 0.077 mm.; length of neck, 0.103 mm., approximately; width of neck, 0.013 mm.; length of egg, 0.265 mm.; width of egg, 0.141 mm.

Aphidencyrtus aphidivorus (Mayr)

Silvestri (1908) reported this species as a secondary parasite on *Aphidius brassicae* Marsh., a braconid aphid parasite, and as a tertiary parasite on

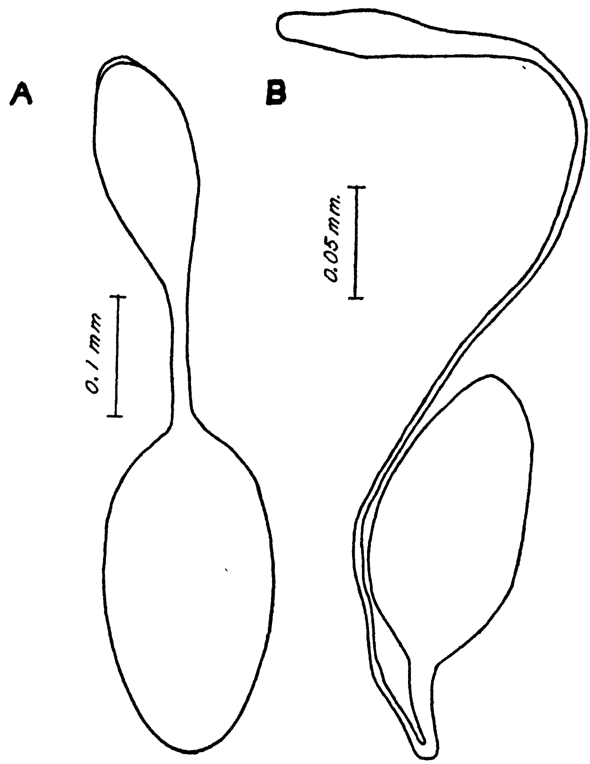

Fig. 8. *A, Anisotylus* sp., ovarian egg. *B, Quaylea whittieri* (Gir.), ovarian egg, the neck partly collapsed.

Allotria vittrix Westw. var. *infusciata* Kief., a cynipid, and he discussed the various stages of development. Griswold (1929) examined the biology of *Aphidencyrtus inquisitor* Girault, now synonymous with *A. aphidivorus,* and recorded the host *Aphelinus jucundus* Gahan.

Ovarian egg.—According to description, the egg is similar to that of *Acerophagus* species described, without distinctive features.

Deposited egg.—The egg is said to be deposited intact within the host, though the bulb is practically collapsed. The various positions or directions assumed by the "pedicel" and reported by Griswold are of no consequence.

Griswold noted that larva assumed a "curved position with the cephalic and caudal ends folded back toward the middle part of the body."

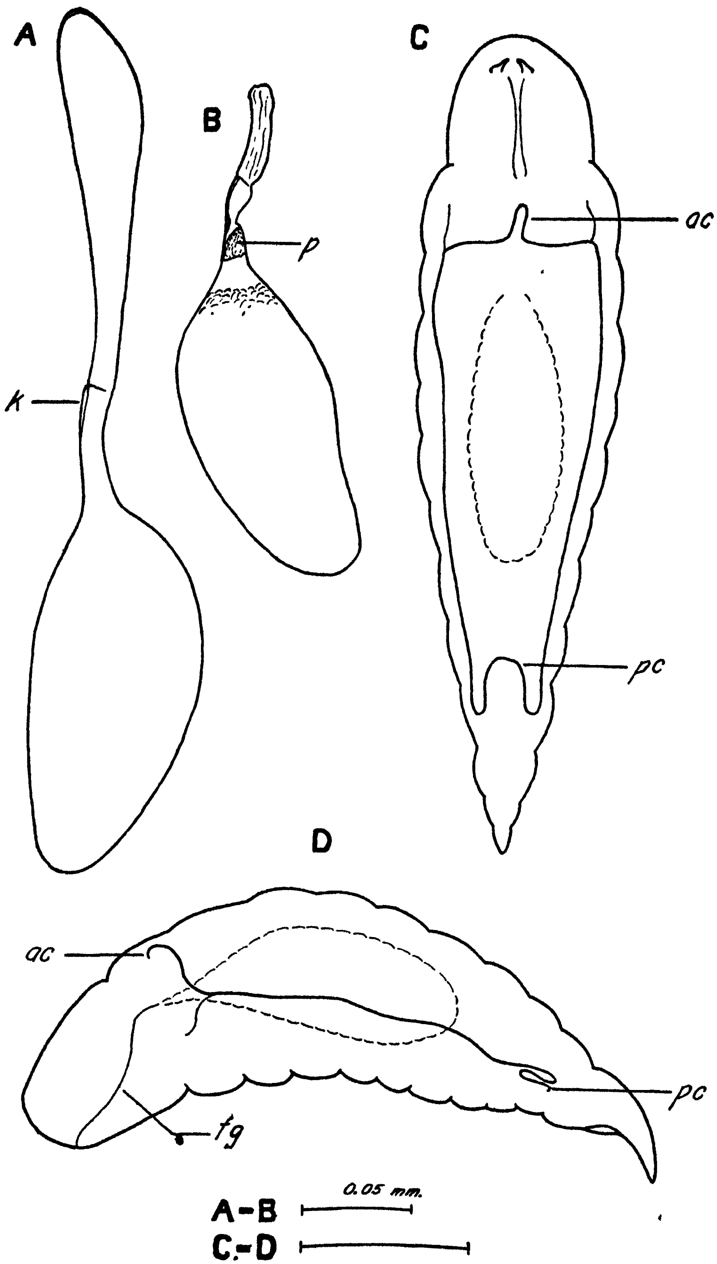

Fig. 9. *Apoanagyrus* sp. *A*, ovarian egg, lateral view; *B*, newly deposited egg; *C*, dorsal view of first instar larva; *D*, lateral aspect of same.

Larva.—The first instar larva has been described as caudate and somewhat crescentic in shape. Although neither Silvestri nor Griswold mentioned the tracheal system, it is apparent from the type of egg and larva that spiracles must be lacking.

Apoanagyrus sp.

Only one female was secured from a native species of mealybug in one locality, and the number of observations was consequently limited.

Ovarian egg.—The structure of the ovarian egg (fig. 9, *A*) is very simple. The neck has a "collar" midway between the bulb and the egg body. The egg proper is only slightly convex on the dorsal side; hence similar to banded eggs. The measurements were: width of bulb, 0.034 mm.; length of bulb and neck to collar, 0.192 mm.; length of neck from collar to egg, 0.051 mm.; length of egg, 0.167 mm.; width of egg, 0.09 mm.

Deposited egg.—The egg (fig. 9, *B*) may be found attached to the integument which surrounds the neck at the collar and lies almost parallel to the surface. The neck becomes constricted immediately below the integument and, if insufficient care is taken with dissections, the main body of the egg is severed from the connection at this point. The remainder of the neck and the bulb extend to the exterior and remain somewhat erect. Forced reinflation of the bulb was prevented by a wad of membranous material at the aperture of the neck.

Larva.—The larva (fig. 9, *C, D*) lies free within the body cavity of the host. Though the abdomen comes to a narrow point, none of the segments is attenuated to form a "tail." Laterally the body is crescentic in shape. The tracheal system is apneustic. The anterior commissure extends in a narrow loop over the foregut; the posterior commissure loops broadly toward the anterior end of the larva. No secondary tracheae could be discerned other than cephalic branches.

Apoanagyrus californicus Comp.

Since this encyrtid attacks many species of native mealybugs in southern California, abundant material could be obtained—a distinct advantage, inasmuch as the parasite was a difficult one with which to work.

Ovarian egg.—This species possesses a much smaller egg (fig. 11, *A*) than the species of *Anagyrus* under investigation. The bulb is quite narrow and the neck is short. The distinguishing feature is the presence of a collar (k). It appears to be a thickening of the chorion which surrounds one half of the neck. Its projecting edge is bidentate. The posterior margin is not sharply demarcated but gradually merges into the remainder of the neck. There is no indication of cells. The structure very readily acquires the color of acid fuchsin in lactophenol. The egg proper is slightly more convex on the ventral side than on the dorsum. The measurements were: length of bulb to collar, 0.128 mm.; maximum width of bulb, 0.017 mm.; length of neck, 0.043 mm.; length of egg, 0.133 mm.; width of egg, 0.064 mm.

Deposited egg.—If the entire host is immersed in the acid fuchsin solution for a few minutes, the protruding neck and collapsed bulb of a newly deposited egg can be readily observed. After several hours the egg is more difficult to

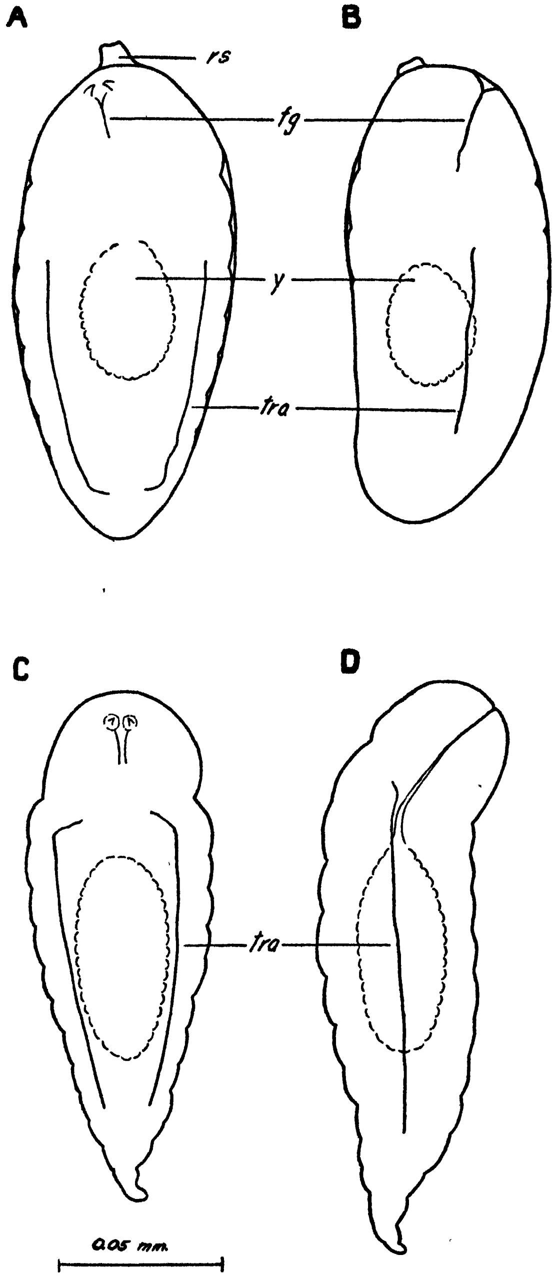

Fig. 10. *Apoanagyrus californicus* Comp. *A,* dorsal aspect of deposited egg containing fully developed embryo; *B,* lateral aspect of the same; *C,* dorsal view of the newly hatched larva; *D,* lateral aspect of the first instar larva.

locate by this method as the exterior portion collapses entirely. Even when the eggs are found and the host is carefully dissected around this point, only rarely is an egg found attached to the integument. The egg proper may sometimes become separated from the neck at oviposition.

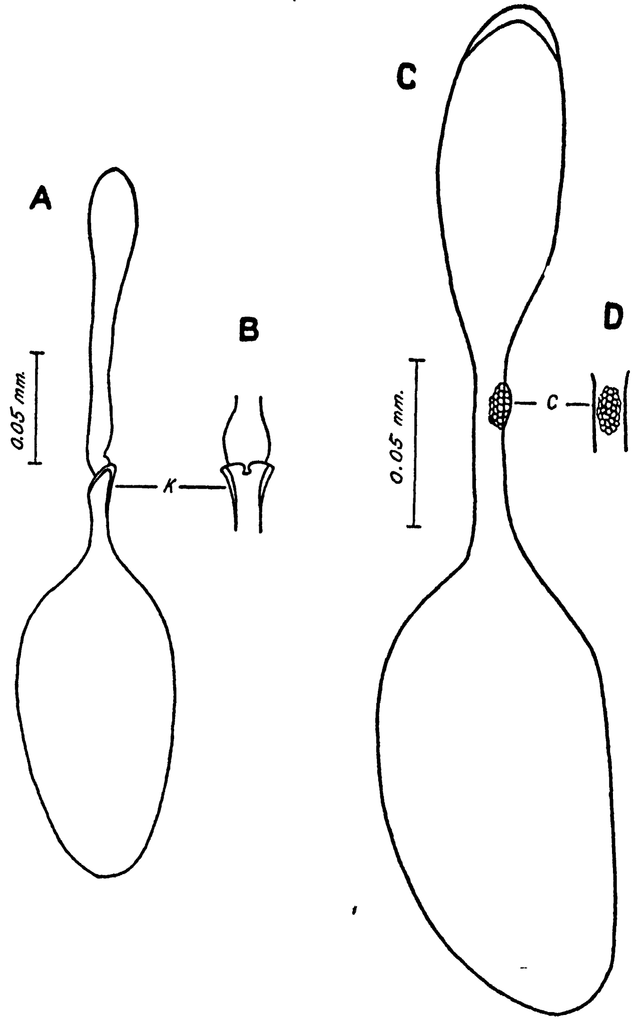

Fig. 11. *A, Apoanagyrus californicus* Comp., ovarian egg, lateral view; *B*, dorsal view of neck of ovarian egg; *C, Leptomastidea abnormis* (Gir.), lateral view of ovarian egg; *D*, dorsal view of portion of neck of ovarian egg.

Before the embryo is fully developed the egg has become detached from the stalk and floats free when the host is dissected. The embryo develops with the anterior end toward the stump of the broken stalk (fig. 10, *A, B*). Eclosion was not observed.

Larva.—The newly hatched larva (fig. 10, *C, D*) is wedge-shaped and widest in the thoracic region. The posterior end tapers to a short, hooked tail. No spiracles could be discerned and they probably do not exist because of the lack

of any band on the egg and the failure of the larva to remain posteriorly enclosed by the shell after hatching. Lateral tracheal trunks and a portion of the anterior commissure appear but the remainder is not visible. Not many hours after eclosion the larva becomes much elongated and the tracheal system is not apparent. The failure to find tracheae may be ascribed to inadequate technique or to the possibility that the structures ceased to function in the usual manner.

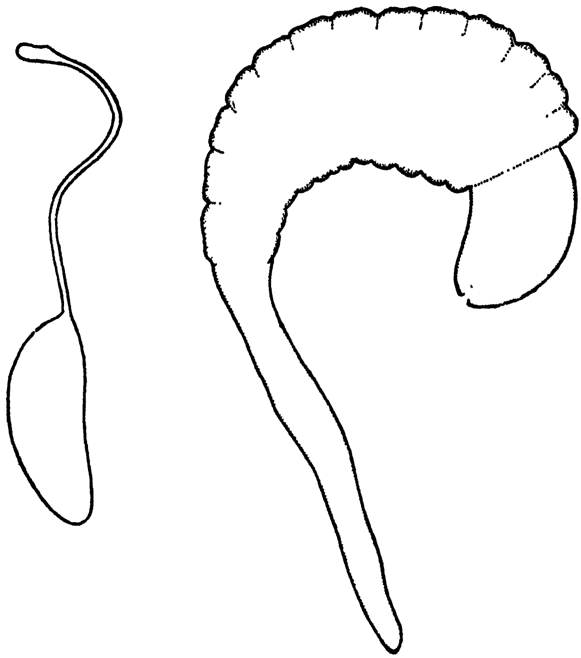

Fig. 12. *Baeoanusia oleae* (Silv.). Newly laid egg and the second instar larvae. From the original drawing by H. Compere. (Compere, 1931*a*.)

In the last embryonic stages only a portion of the tracheae is observable. From the small number of successful dissections, it appeared that only three-fourths of the tracheal trunks and a portion of the posterior commissure assume the silvery sheen.

Baeoanusia minor (Silv.)

Compere (1931) briefly investigated this species but was not able to supply detailed information. The egg and larva are probably similar to those of *Baeoanusia oleae.*

Baeoanusia oleae (Silv.)

It is apparent from the brief description of the developmental stages of this parasite by Compere (1931) that the egg and larva differ in no major respect from other secondary parasites of scale insects. The deposited egg has a long stalk, and in his illustration (see fig. 12), the bulb remains attached though collapsed. The eggs are deposited free within the host, but Compere noted that

in his specimens some of the eggs were occasionally too entangled in the internal organs to float out when the host was dissected.

The first-stage larva is not described. From the drawing of the second stage (see fig. 12) it is reasonable to assume that the first instar larva is of similar structure and consequently devoid of spiracles.

Blastothrix longipennis How.

This species is a common enemy of many kinds of lecanine scales in southern California. Although quantities of adults emerged from hosts which had been obtained from widely separated localities, none contained ovarian eggs. A series of females was retained in the laboratory during 1936 and dissected at intervals. On June 15, August 25, and December 26 no indication of developing ovaries was apparent. Similar results were obtained with females found feeding on aphid honeydew in October of that year. Some were dissected at the time of collection and others on December 26; during the interval they were fed weekly on honey and were refrigerated. None contained eggs. Fortunately, however, one female collected in the early summer of 1936 from an infestation of *Lecanium corni* had mature ovaries.

The deposited eggs and the larval stages were observed in field-collected scale. The only evidence that the stages found in the scale and the ovarian eggs from the single female were the same species is the apparent identity in the egg structure. Although such evidence is circumstantial, I believe it to be reliable.

Ovarian egg.—This stage is illustrated in figure 13. The measurements were: length of bulb, 0.1 mm.; width of bulb, 0.047 mm.; length of neck, 0.06 mm.; width of neck, 0.013 mm.; length of egg, 0.175 mm.; width of egg, 0.107 mm.; length of band on egg, 0.06 mm.; width of band on egg, 0.039 mm. The tip of the bulb is very slightly thickened. The neck is of uniform width. The band covers half of the dorsal side for most of the length but widens slightly toward the bulb end. The cells are uniform in size. On the egg body the band differs from those of most other eggs in its nearly circular outline. The cells of the center section are noticeably larger than those of the marginal areas. In the lateral aspect the thickening presented by the band is just visible.

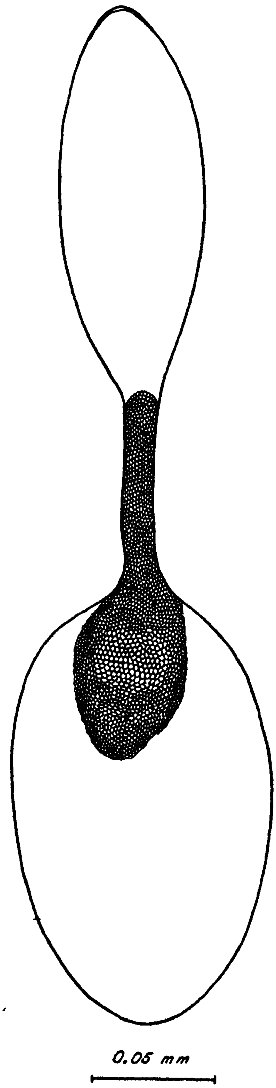

Fig. 13. *Blastothrix longipennis* How. Ovarian egg.

Deposited egg.—As was noted above, deposited eggs were secured only from field-collected material. Three species of host were dissected, and because the eggs found were smilar to the ovarian eggs obtained from the single female, and since females of the same species emerged from these scales, it is assumed that they represent single encyrtid species.

The eggs are laid in medium-sized to small hosts and are inserted dorsolaterally, usually at the posterior end of the scale. In many eggs, especially

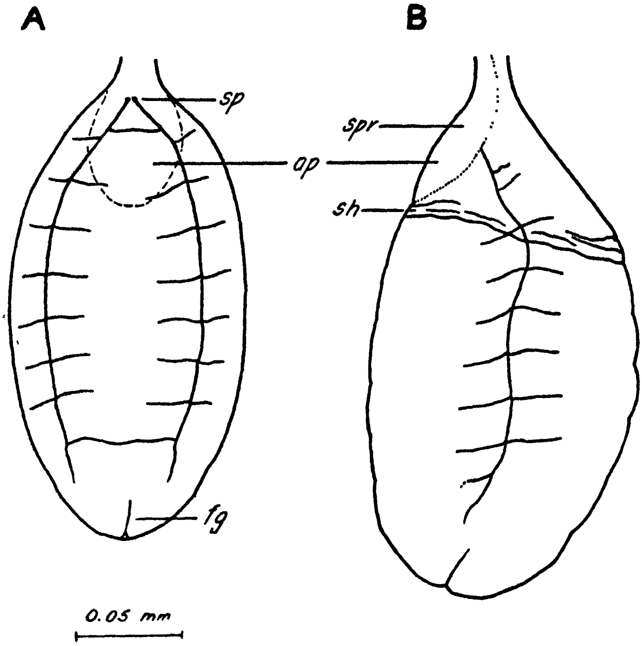

Fig. 14. *Blastothrix longipennis* How. *A*, larva immediately prior to eclosion, dorsal aspect; *B*, newly hatched larva in lateral aspect.

those near the margin of the scale, the silvery band is clearly visible through the integument. The collapsed bulb remains attached to the neck protruding from the host.

One deposited egg was found which clearly showed the embryo to develop with a head at the stalk end of the egg. A later stage of development is shown in figure 14, *A*. The embryo has reversed itself, though eclosion has not occurred. The tracheal system is full of air.

Larva.—After eclosion, the shell, except for the band, lies wrinkled over the posteriormost segments of the larva (fig. 14, *B*). The band holds the remains erect. There are two nearly contiguous spiracles attached to the upper central area of the band on the egg proper. Lateral branches of the tracheae are well developed.

Blastothrix sericea (Dalm.)

Imms (1918) and Silvestri (1919) have given creditable accounts of this scale parasite. Imm's work is notable in that it contains the first description of a metapneustic tracheal system in Hymenoptera.

The intricate structure of the egg was described in detail by Silvestri. Imms gives no account of the ovarian egg nor does he mention any structures which may be compared with those in Silvestri's report, according to which the egg

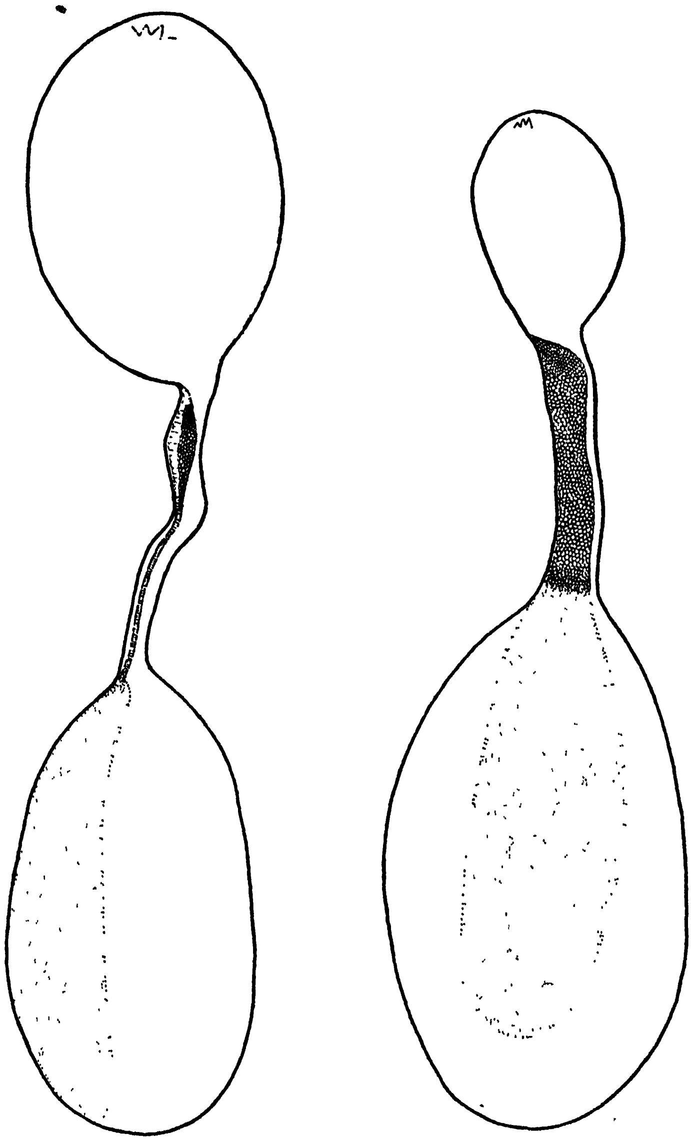

Fig. 15. Left, *Encyrtus infidus* (Rossi) ovarian egg. Right, *Blastothrix sericea* (Dalm.) ovarian egg. (Redrawn from Silvestri, 1919.)

has a prominent aeroscopic plate which extends nearly to the apex of the egg proper. The ovarian egg, redrawn from Silvestri, is shown in figure 15, right.

Imms and Silvestri agree that the respiratory system is metapneustic. Figure 16, right (also from Silvestri), gives a diagrammatic presentation of the first instar larva.

Bothriothorax nigripes How.

This is the only species obtained which is known to attack Diptera; it is supposedly common on syrphid flies in California. Host material was too inadequate to permit definite conclusions to be reached concerning the deposited egg and larva.

The ovarian egg (fig. 17) is singularly marked for the length of the neck with a fine line apparently having no cellular structure. There is indication that the line extends some distance on the egg proper.

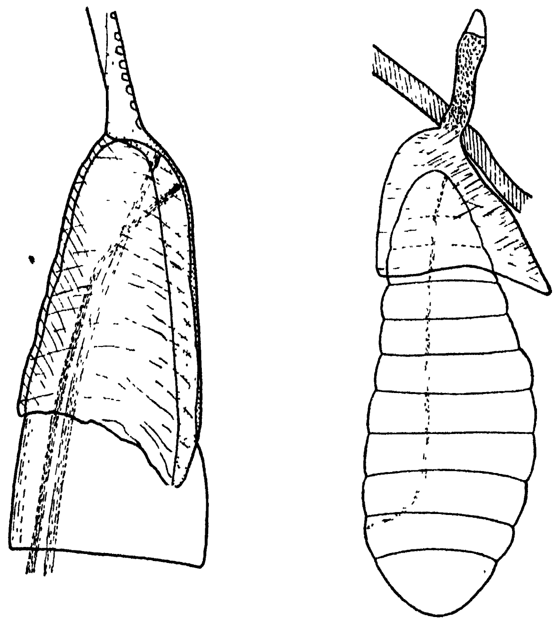

Fig. 16. Left, *Phaenodiscus aeneus* (Dalm.), posterior portion of the larval body enclosed in the remains of the eggshell. The tracheae lead directly to the aeroscopic plate. Right, *Blastothrix sericea* (Dalm.), newly hatched larva suspended from the integument of the host scale. (Redrawn from Silvestri, 1919.)

The developmental stages may be quite similar to that described for *Ectroma* sp.

Carabunia myersi Watrst.

Myers (1930), in discussing this parasite of *Clastoptera* nymphs, omits any description of the ovarian egg.

The deposited egg "was found floating loose among the abdominal organs, but may have become detached during dissection." It has a short pedicel which is about half as long as the egg. The chorion is thin, with no evident sculpturing.

The body of the newly hatched larva is crescentic and tapers sharply to a long tail, which is usually clasped by the remains of the eggshell. The tracheal system is apneustic.

Cerapterocerus mirabilis Westw.

The only investigation of this hyperparasitic species was made by Silvestri (1919) and adequate descriptions were given.

The ovarian egg has a thin nonbanded chorion. The newly deposited egg lies free in the body cavity of the primary host. As development proceeds, the anterior part and the neck remain attached as a membranous appendage to the main egg body.

The first instar larva (fig. 18) has an elongate body with the abdominal segments prolonged into a sharp tail. The tracheal system is apneustic but well developed.

Cheiloneurus inimicus Comp.

The early stages of this hyperparasite of scales have been discussed by Compere (1925). The ovarian egg lacks distinguishing features. In that stage I found its bulb to be long and narrow, slightly wider than the neck and undifferentiated from it. The egg proper is widest at the anterior end and tapers toward the apex. Measurements were: length of bulb and neck, 0.225 mm.; length of egg, 0.18 mm.; width of egg, 0.073 mm.

According to Compere the egg is deposited free within the body of the primary hymenopteron parasite. A pedicel remains attached to the egg and becomes increasingly inconspicuous as the egg increases in size with the growth of the embryo.

The larva is of the tailed type. According to Compere's drawing (fig. 19) the tail represents an attenuation of the 14th visible body segment and is half as long as the remainder of the larva. No information is supplied concerning the tracheal system, which is probably apneustic.

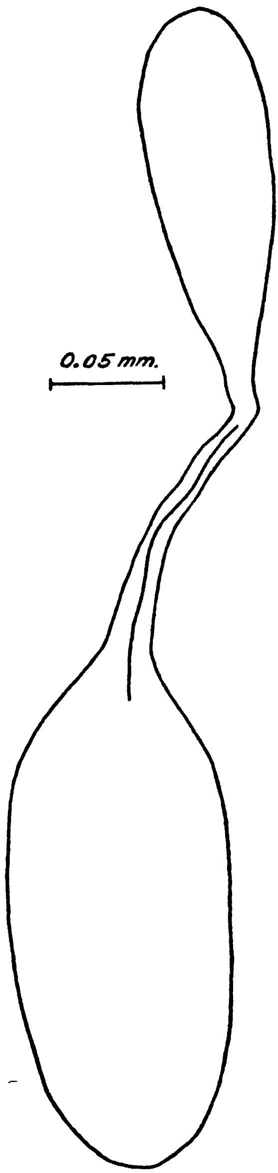

Fig. 17. *Bothriothorax nigripes* How. Ovarian egg. The "line" on the stalk has no cells.

Cheiloneurus noxius Comp.

This species is similar in its habits and bioloby to the aforementioned species and has been discussed in an article by Le Pelley (1937). The ovarian egg has a moderately long neck and the bulb is slightly greater in width. The deposited egg lies free in the body of the host and the collapsed bulb is still attached. Upon eclosion the larva frees itself completely from the egg shell. The larva is of the tailed type common to many apneustic encyrtid larvae. Le Pelley does not mention the tracheal system nor does it appear in the illustrations. By analogy the system is apneustic.

Chrysopophagus compressicornis Ashm.

The only investigation on the biology of any species of *Chrysopophagus* was made by Clancy (unpublished manuscript). *Crysopophagus compressicornis* is a hyperparasite of *Chrysopa californica* Coq. and *Chrysopa majuscula* Banks.

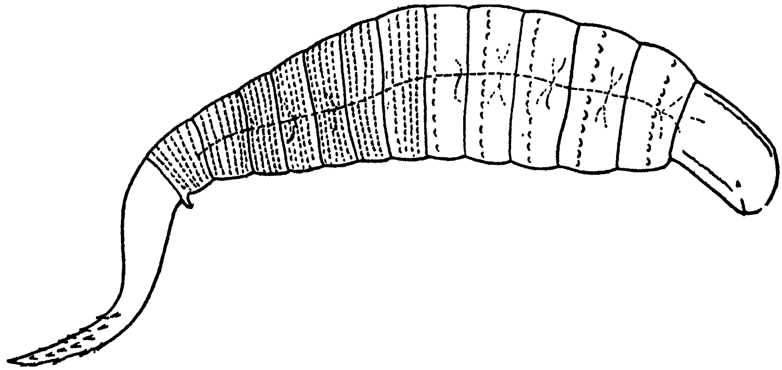

Fig. 18. *Cerapterocerus mirabilis* (Westw.). Newly hätched larva. (Redrawn from Silvestri, 1919.)

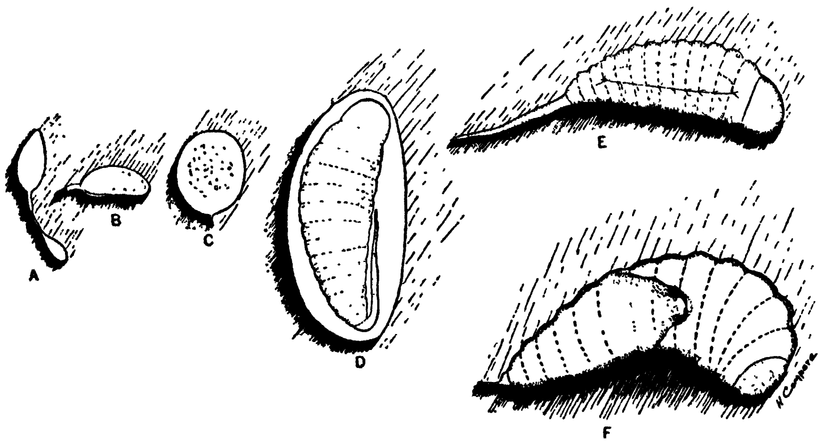

Fig. 19. *Cheiloneurus inimicus* Comp. *A*, ovarian egg; *B*, newly deposited egg; *C*, egg in process of growth; *D*, egg just after hatching, showing larva within; *E*, first stage larva; *F*, partly grown larva with moult skin adhering. From the original drawing by H. Compere. (Compere, 1925.)

The ovarian egg is of the simple double-bodied type. The deposited egg is only slightly different. The bulb is attenuated but intact and together with the neck shrivels as the egg increases in size. The stalk may be anchored occasionally to tissues or fat body but never to the host's integument.

The deposited egg increases to five times the original size. The larva develops with the head at the anterior end and hatches from that position. All but the head and tail is surrounded by a trophamnion, the chorion apparently disappearing.

The larva is of the tailed type and usually somewhat crescentic in shape. The tracheal system is apneustic.

Clausenia sp.

This unidentified species from an unknown host was among the adults that emerged at the University of California Citrus Experiment Station from scale material collected by Harold Compere in South Africa. It was not propagated or released. Since the early stages of species of the genus have not heretofore been described, a description of the egg of this unknown species is given.

The ovarian egg (fig. 20) is nearly identical with the eggs of *Apoanagyrus* spp. The only possible suggestion of a band is a collar on the neck. In all other respects the egg structure is simple. The egg measured as follows: length of egg, 0.146 mm.; width of egg, 0.077 mm.; length of neck from collar, 0.034 mm.; width of neck, 0.012 mm.; length of bulb to collar, 0.299 mm.; maximum width of bulb, 0.034 mm.

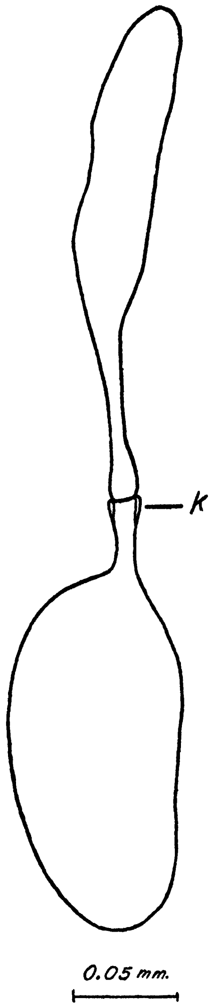

Fig. 20. *Clausenia* sp. Ovarian egg, lateral aspect. Note band which rings neck at *K*.

Coccidoxenus niloticus Comp.

This species was among those introduced by Compere from South Africa. During its propagation material was made available for study.

Ovarian egg.—The ovarian egg (fig. 21, *A*) consists of two large bodies connected by a moderately long neck. The bulb is much larger than the egg body. Within the ovarioles the bulb is distended, whereas the egg proper is not completely filled and the shell is wrinkled. When the ovarian egg is compressed to smooth out the folds, the bulb extends enormously so that its volume must be at least twice that of the main body. The neck is curved toward the bulb and resists all attempts to straighten it. The measurements were: length of bulb, 0.468 mm.; width of bulb, 0.36 mm.; length of neck, 0.288 mm.; width of neck, 0.026 mm.; length of egg, 0.423 mm.; width of egg, 0.19 mm.

Fig. 22, *A* and *B*, gives some indication of the elaborate appearance of the anteriormost portion of the band on the neck. The features immediately noticeable are the greater width of the neck, the grading of cell size in the portion of the band that nearly circumscribes the neck, and the sudden reduction to rows of stipples throughout the remainder of the neck. In the lateral view an abrupt thickening of the margins of the larger cells is seen, which may be significant.

Figure 21, *B*, shows in detail the band on the egg proper. The breadth is in itself distinctive. The cells are mostly very minute, but some are a little larger and are arranged in a definite pattern of polygons.

Deposited egg.—The stalks of the deposited eggs protrude from the dorsum of the scale host in such a manner as to look like little white hooks. The collapsed bulb remains attached (see fig. 24, *A*). The portion of the stalk within the host is curved so that the dorsal surface of the egg is nearly parallel to the integument.

Larva.—The newly hatched larva (fig. 24, B) exhibits no striking departure from the other metapneustic larvae except the larger diameter of the

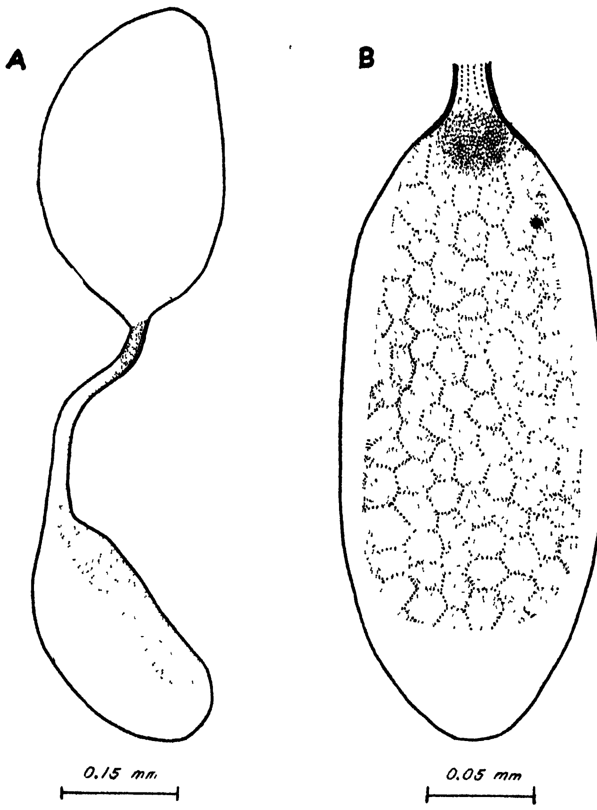

Fig. 21. *Coccidoxenus niloticus* Comp. *A*, ovarian egg, lateral aspect; *B*, dorsal view of egg proper, showing detail of aeroscopic plate. The design is formed by larger cells.

tracheae. The spiracles are placed at the stalk end when the larva is newly hatched, but in the later instars their position is shifted toward the broader portion of the band. All the eggshell collapses except the band.

Comperiella bifasciata How.

This species has been adequately discussed by Compere and Smith (1927). The newly deposited eggs are found free wthin the scale host or loosely attached to its integument. The stalk partly collapses after deposition and apparently serves no useful function. It is apparent from Compere's drawing (his fig. 25, 3) that the embryo develops with its head at the stalk end of the

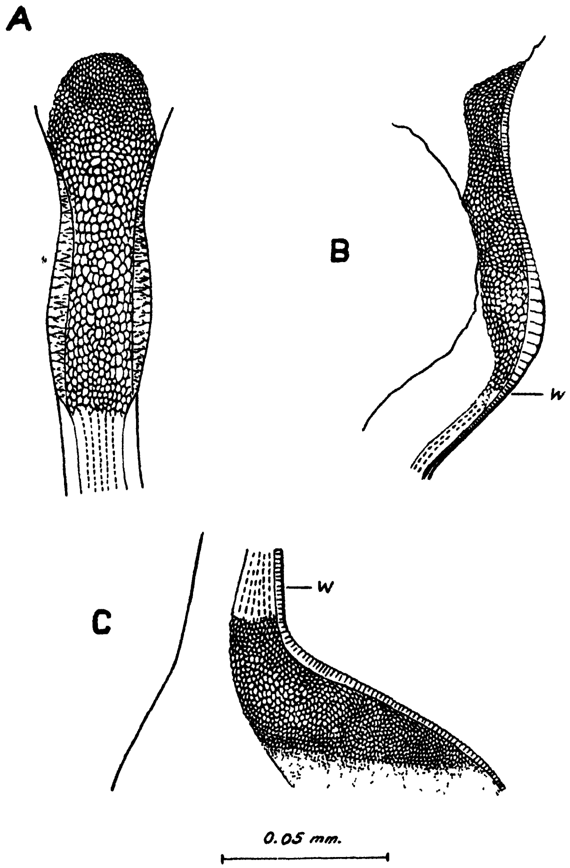

Fig. 22. *Coccidoxenus niloticus* Comp. *A* and *B*, egg, showing two aspects of distal end of neck; *C*, lateral view of distal end of egg proper.

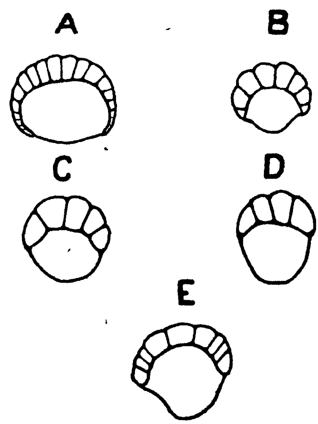

Fig. 23. *Coccidoxenus niloticus* Comp. Sectional views of stalk. *A*, *B*, and *C* in sequence in the area of large cells; *D*, the remainder of the neck; *E*, sections immediately prior to the egg proper. Semidiagrammatic.

egg. At eclosion, instead of issuing from the egg the larva remains with nearly half of the posterior end enclosed. According to whether the egg is attached to the host's integument or free within the host, the larva is secured or free floating. The tracheal system consists of a simple short tracheal trunk without spiracles.

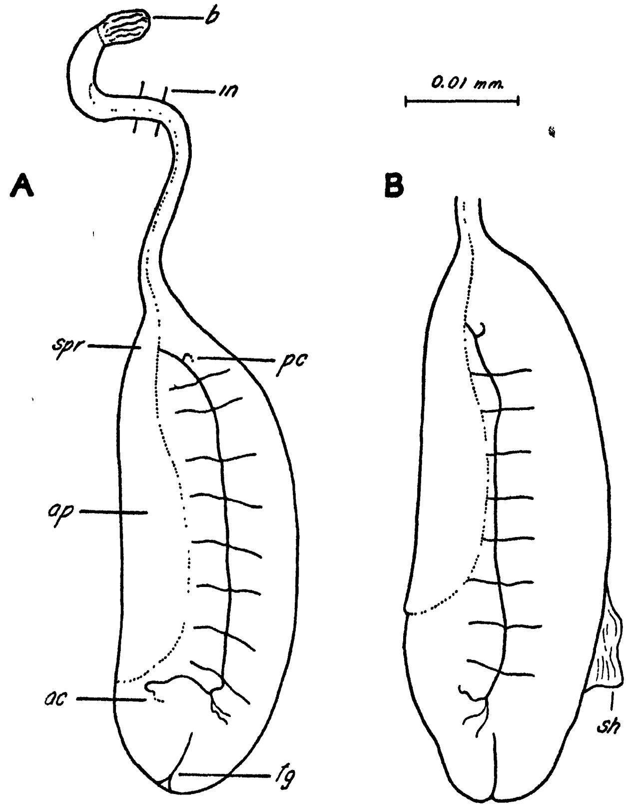

Fig. 24. *Coccidoxenus niloticus* Comp. *A*, deposited egg, showing fully developed embryo; *B*, newly hatched larva almost wholly enclosed by shell.

Comperiella unifasciata Ishii

The deposited egg was noted by Taylor (1935) to be strongly attached to the body wall of the scale host. Since he found "no special apparatus for attachment," he assumed that it "must be effected by some adhesive substance." The stalk probably functions in this respect.

The first instar larva was noted to taper gradually to a point at the posterior end. A tracheal system was not found until the last instar.

Diversinervus elegans Silv.

Compere (1931) stated that the deposited eggs of this scale parasite were of the "aeriferous type" and were noted to be "enclosed in the hind intestines suspended on a long stalk, the end of which is inserted through the anal tissue."

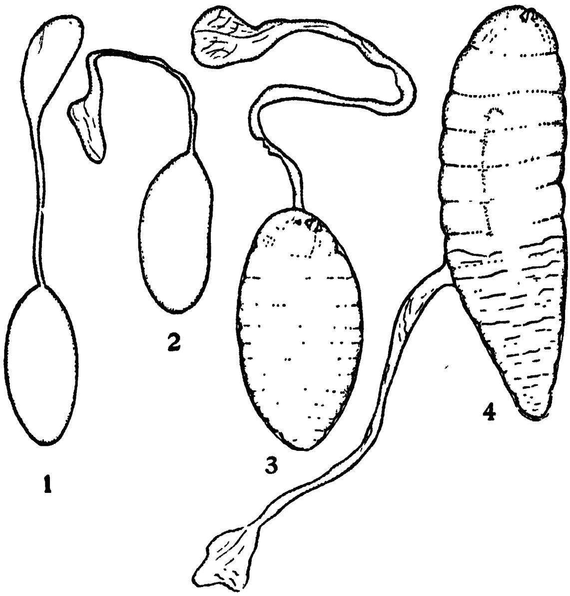

Fig. 25. *Comperiella bifasciata* How. 1, Ovarian egg. 2, Newly laid egg. 3, Egg shortly before hatching. Note position of the embryo. 4, First instar larva. From the original drawing by H. Compere. (Compere and Smith, 1927.)

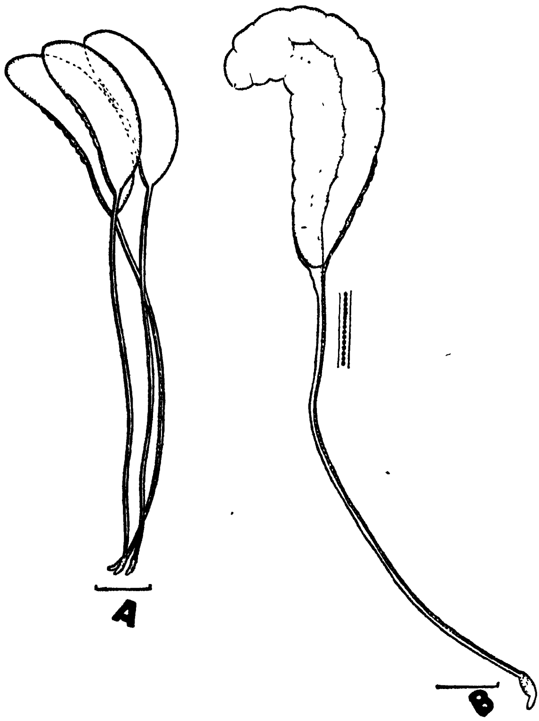

Fig. 26. *Diversinervus elegans* Silv. *A*, cluster of three newly laid eggs; *B*, first stage larva. (After Compere, 1931*b*.)

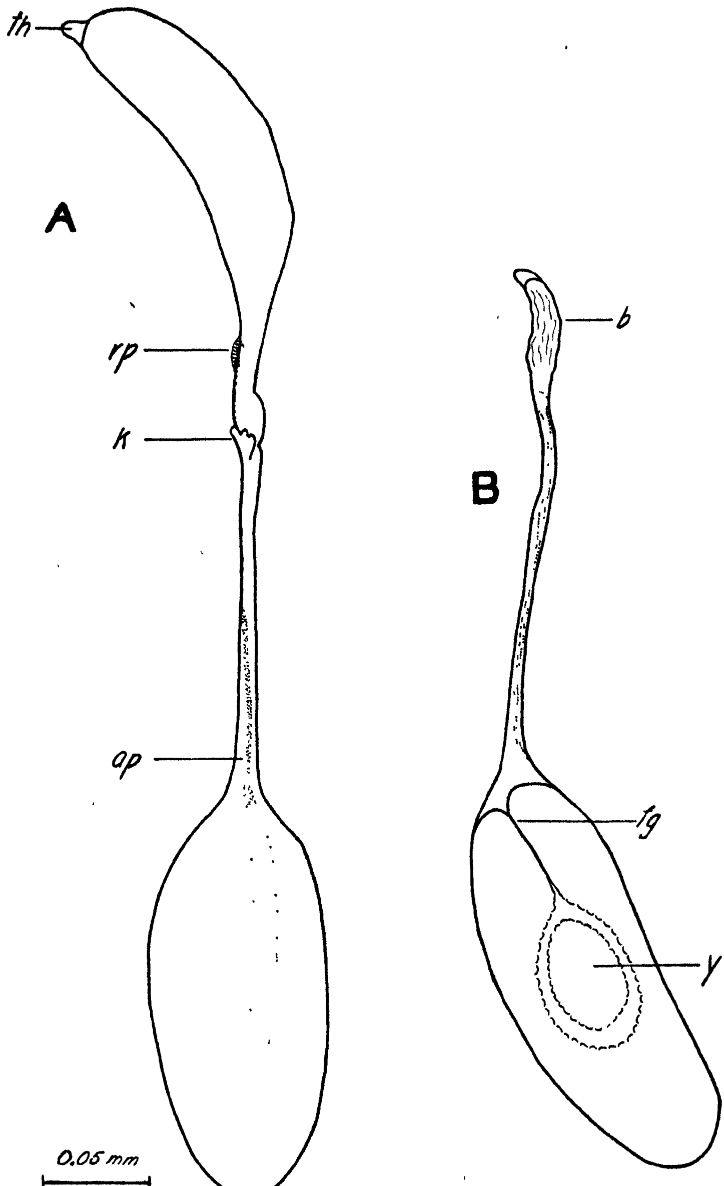

Fig. 27. *Ectromatopsis americana* (How.). *A*, ovarian egg; *B*, deposited egg containing embryo.

That the egg possesses a band is indisputable, as is evident from Compere's illustration (see fig. 26) and the term "aeriferous."

The newly hatched larva was not described, but it would appear from the drawing that the tracheal system is not apneustic but probably has a single pair of spiracles.

Ectromatopsis americana (How.)

This species is a relatively uncommon parasite of native California mealybugs. Although it was propagated with ease the studies of the developmental stages proved difficult.

Ovarian egg.—The ovarian egg was not properly studied. The drawing (fig. 27, *A*) was reconstructed from a series of sketches of a few poor mounts and

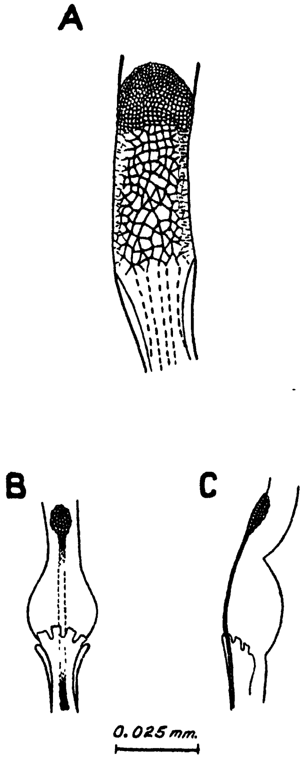

Fig. 28. *A, Microterys saissetia* Comp., anterior of neck of egg, dorsal view. *B* and *C, Ectromatopsis americana* (How.), two aspects of anterior end of neck.

is therefore not a true camera-lucida drawing. The dimensions can be estimated from the accompanying scale.

The bulb is much longer than it is wide and its apex is thickened into a nipple-like projection. The neck is nearly as long as the egg itself and bears a collar near the bulb. Figure 28, *B* and *C*, shows this region of the neck in detail. The collar surrounds half of the stalk and its projecting margin is dentate. A very minute band extends along the entire length of the neck. A small portion at the bulb end is definitely composed of cells and these may continue as far as the egg proper. On the main body of the egg the band widens slightly and continues for two-thirds its length. The structure is extremely difficult to see even in the best preparations.

Deposited egg.—For oviposition very small mealybugs are selected. Since the egg is relatively large it occupies most of the body of the host and the stalk is doubled back over the egg. The egg is attached to the integument by the

stalk. The collapsed bulb remains intact. Even though a band may be observed in the ovarian egg, only a portion has the silvery appearance after deposition. This portion consists of a silvery "string" extending the length of the neck but ending before the body is reached. This condition is correlated with the tracheal structures of the larva.

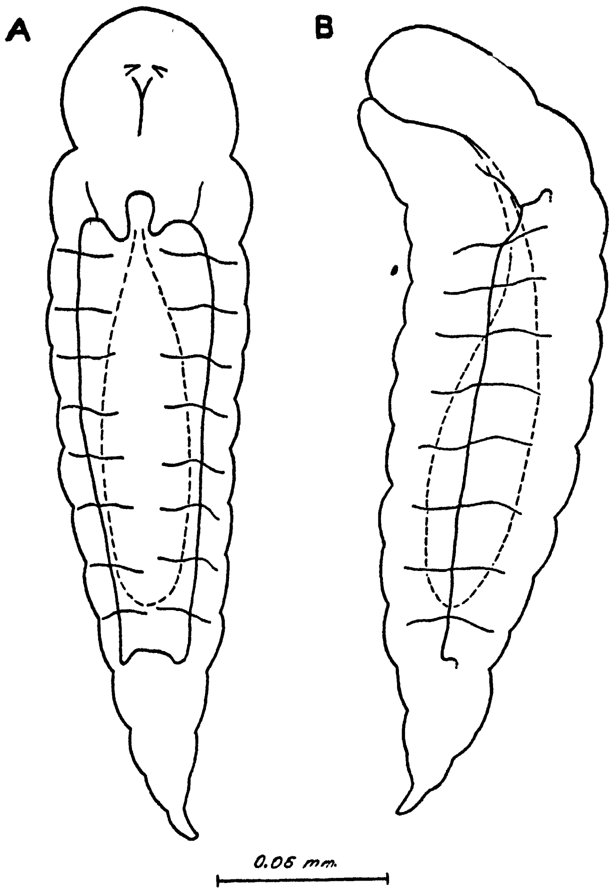

Fig. 29. *Ectromatopsis americana* (How.). First instar larva. *A,* dorsal view; *B,* lateral view.

The embryo develops with its head at the stalk end (fig. 27, *B*). Eclosion was not observed.

Larva.—The newly hatched larva is elongate, laterally somewhat crescentic in shape, with a broad anterior region and a taperng posterior. The tracheal system is closed. The drawings (fig. 29) are reconstructions from camera-lucida sketches.

Encyrtus barbatus Timb.

No description of the egg is available. Ishii (1932) has illustrated and described the young larva, supposedly the first instar. I strongly suspect that the stage is a much later one, possibly the third or fourth. In the drawing the

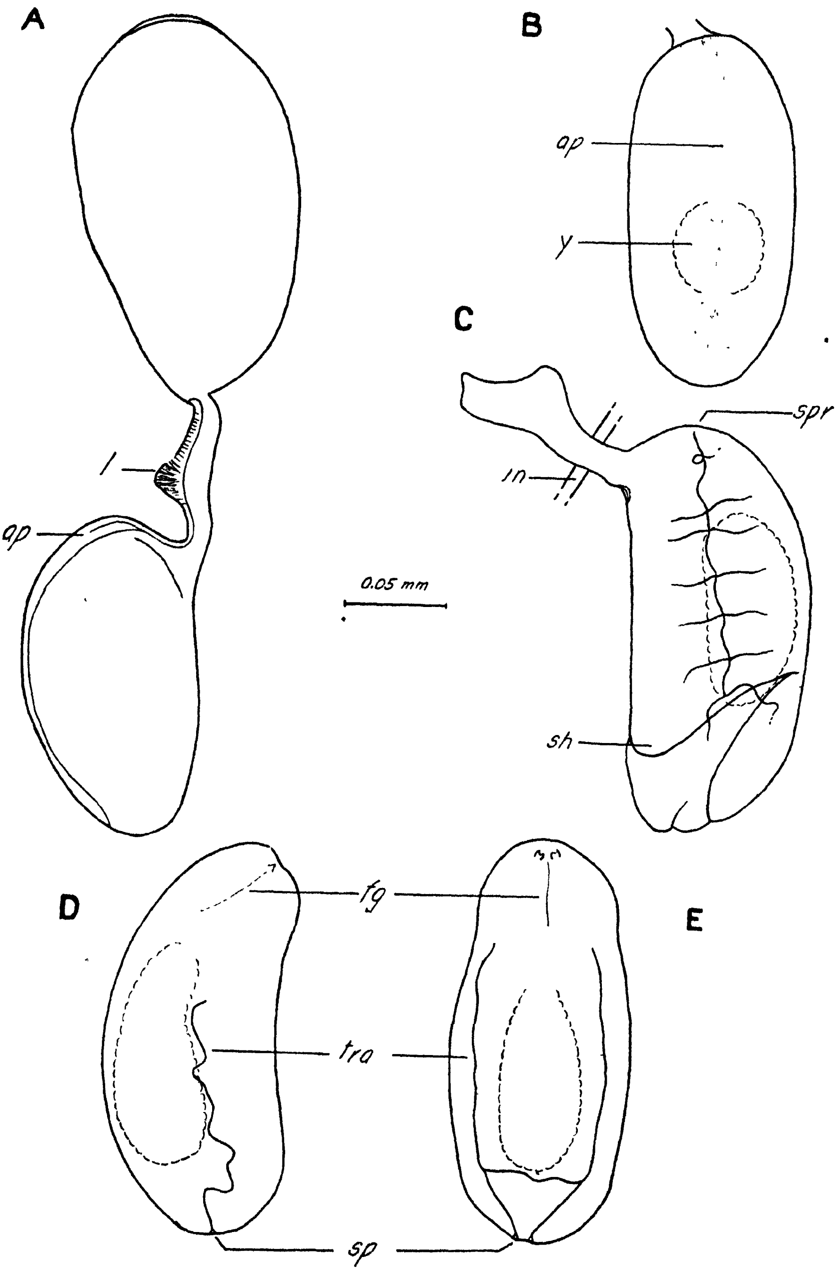

Fig. 30. *Encyrtus fuliginosus* Comp. *A*, ovarian egg in the lateral aspect to show the band on the convex ventral side; *B*, posterior portion of the deposited egg (note position of yolk); *C*, newly hatched larva; *D* and *E*, two views of first instar larva removed from eggshell.

eggshell is extremely small compared with the size of the larva. The long tail with a pair of spiracles at the tip, and the additional spiracles on the thorax and abdomen are characteristic of later instars of *Encyrtus.*

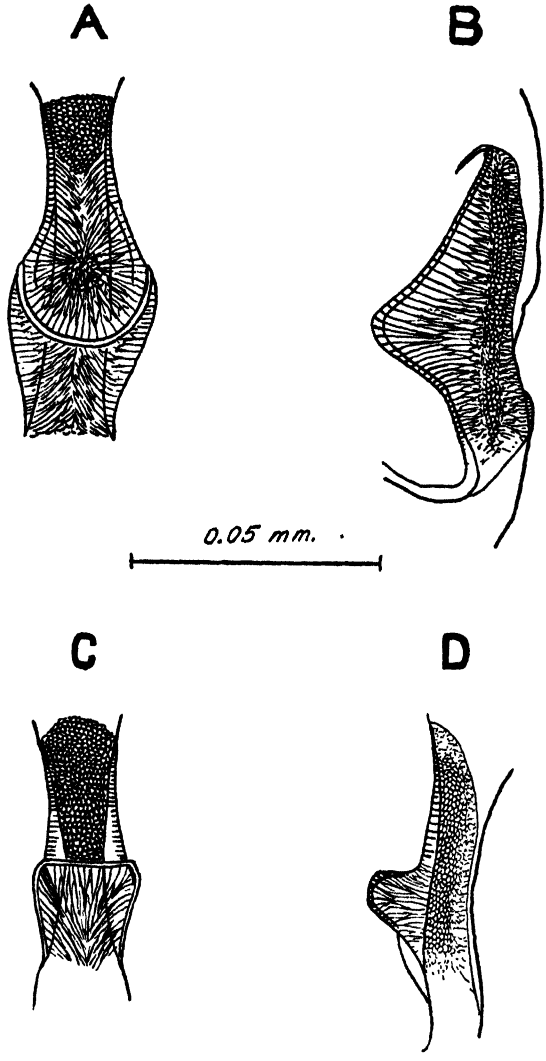

Fig. 31. The lip of two species of *Encyrtus,* dorsal and lateral aspects. *A* and *B, Encyrtus fuliginosus* Comp.; *C* and *D, Encyrtus infelix* (Embl.).

It does not seem likely that the egg or larva of this scale parasite differs in any important respect from those of the other species of *Encyrtus.*

Encyrtus fuliginosus Comp.

This species is not native to California but was introduced from South Africa by Compere (1940) for use against *Saissetia oleae* Bern. Material for this study was made available during the propagation of the species.

Ovarian egg.—The features common to all the *Encyrtus* eggs that I examined are the comparatively large bulb, the short neck with the projecting lip, the lateral attachment of the neck to the egg body, and the position of the band on the more convex or ventral side. The only portion of the band readily discernible is the prominent lip. The remainder of the band is apparent only after the egg is deposited. The egg of *Encyrtus fuliginosus* may be regarded as typical. Figure 30, *A* shows a lateral view. When freshly dissected the bulb is large and fully rounded, whereas the egg proper is smaller and wrinkled from only partial distension. The peculiar neck structure is illustrated in figure 31, *A* and *B*. The lip is highly complicated and defies comprehensive description. It looks as if it were an agglomeration of interconnecting cells. The drawings were as accurately made as possible and present the appearance as viewed by the usual laboratory microscope.

The measurements were: width of bulb, 0.116 mm.; length of bulb, 0.188 mm.; width of neck, neck, 0.03 mm.; length of neck, 0.068 mm.; width of egg, 0.09 mm.; length of egg, 0.163 mm.

Deposited egg.—The stalk of the egg passes

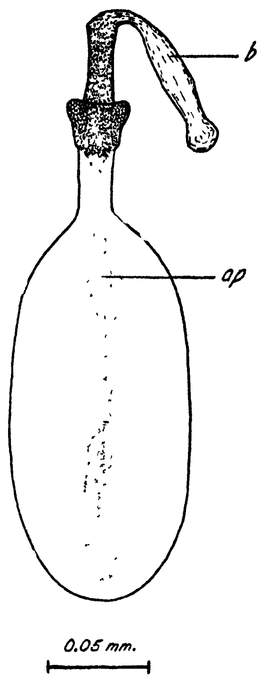

Fig. 32. *Encyrtus infelix* (Embl.). Deposited egg, showing the aeroscopic plate (ap).

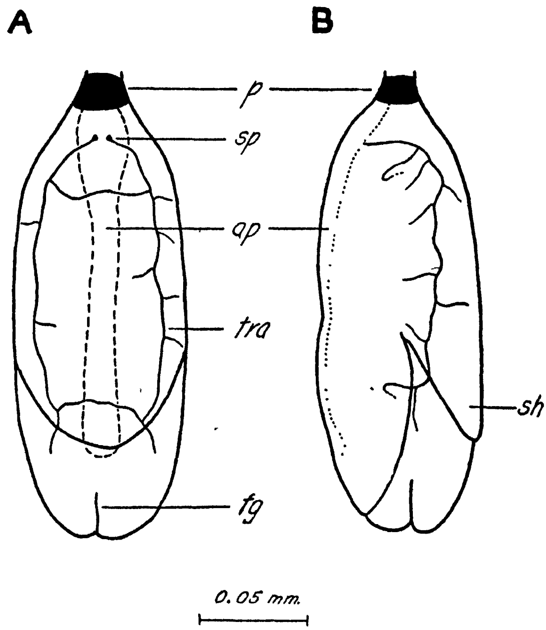

Fig. 33. *Encyrtus infelix* (Embl.). Newly hatched larva. *A*, ventral view; *B*, lateral view.

through the dorsum of the scale. Of those eggs examined the bulb was invariably absent as a complete structure. It was either entirely lacking or a portion remained as a stringy attachment. The long, narrow, silvery band extends nearly to the tip of the egg. Cells appear only as stippling. Those in

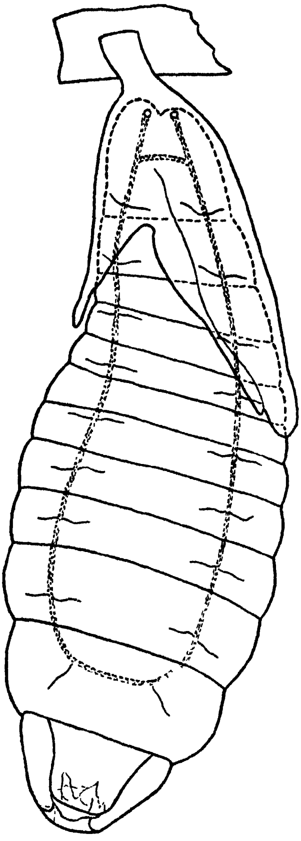

Fig. 34. *Encyrtus infidus* (Rossi). Newly hatched larva encapsulated posteriorly by the shell of the egg, which is suspended from the integument of the host. (Redrawn from Silvestri, 1919.)

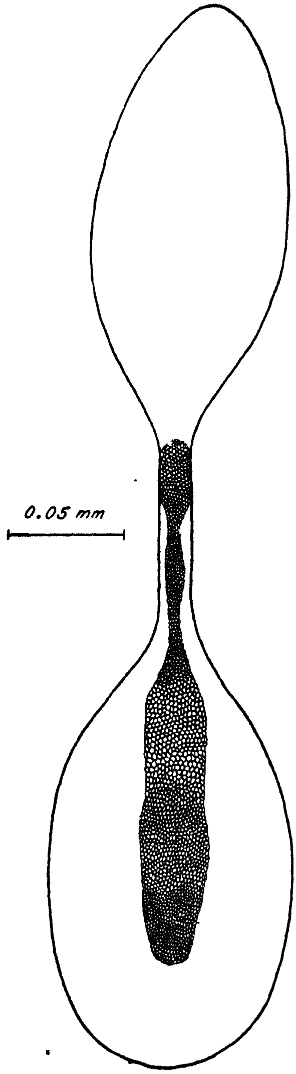

Fig. 35. *Erythaphycus argyrocomus* Comp. Ovarian egg, dorsal view.

the center section appear to be slightly larger. Since the band is on the side opposite that with the deposited eggs of other genera, it is not readily distinguishable through the host's integument. However, after embryonic development has proceeded to the point at which the egg is partly translucent the band may be discernible.

The embryo develops with the head toward the stalk end. This is evident from the position of the yolk as the larva develops (fig. 30, *B*).

Larva.—After eclosion the larva is suspended in the eggshell with all the body except the head enclosed by the chorion (fig. 30, *C*). The two spiracles are placed at the extreme end of the egg at the center of the band. There is no visible plug in the stalk of the eggshell.

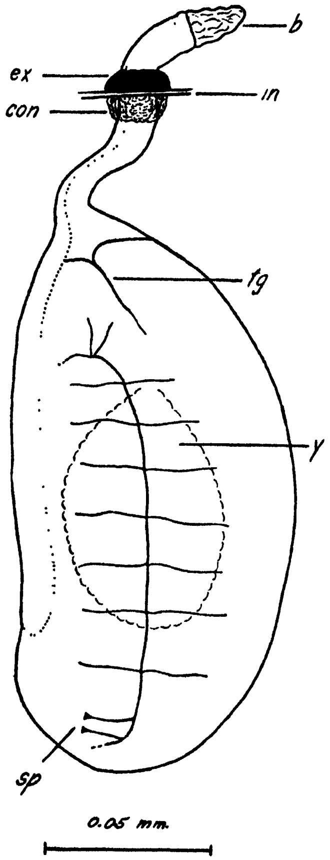

Fig. 36. *Erythaphycus argyrocomus* Comp. Deposited egg containing fully developed embryo.

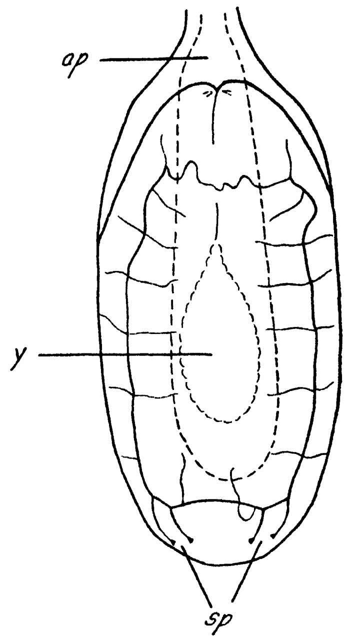

Fig. 37. *Erythaphycus argyrocomus* Comp. Ventral aspect of egg proper, showing tracheal system of the completely developed embryo.

The larva is firmly attached to the shell and no attempts to remove it succeeded. After hosts containing young parasite larvae had been immersed in stain-saturated kerosene-xylene mixture for other purposes, the attachment was less firm and the larvae could occasionally be removed intact. The newly hatched larva is shaped like a sausage (fig. 30, *D* and *E*). The two spiracles are flush with the rounded posterior end, as opposed to later instars which have their posterior extremities prolonged into a forked tail with a single spiracles on each process.

Lateral tracheal branches are barely distinguishable. Their number and distribution vary.

Encyrtus infelix (Embl.)

This parasite of hemispherical scale, *Saissetia hemispherica* (Targ.), was the first encyrtid species of which the biology was investigated to any great extent. In her monumental work Embleton (1904) describes a portion of a structure which in this paper is referred to as an aeroscopic plate or band, a peculiarity of the encyrtid egg which until recently has been largely overlooked by other workers.

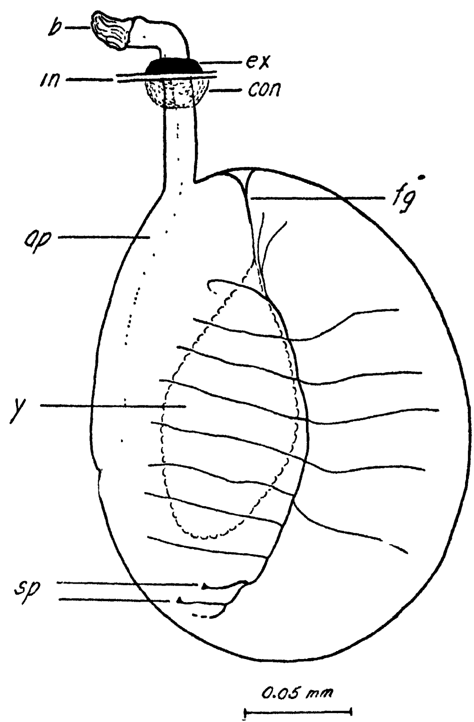

Fig. 38. *Erythraphycus argyrocomus* Comp. Deposited egg immediately prior to eclosion.

Ovarian egg.—The undeposited egg is almost identical with that of *Encyrtus fuliginosus.* The bulb is nearly spherical and as large as, or larger than, the main body of the egg. Embleton (1904) and Thorpe (1936) stated that the bulb disappears with the old ovarian eggs. I could not confirm this; on the contrary, the bulb was found to be fully distended. The egg proper was somewhat collapsed and the chorion was wrinkled.

The neck has a prominent lip which differs from that of *Encyrtus fuliginosus* in its more acute angle of projection from the neck, but in structure is fully as complicated. Cells of the band are apparent here as elsewhere on the neck. No doubt Embleton (1904) saw the band at this point, for fine papillations or striations were noted on the wall of the tube. The band on the egg proper is either not visible or, on those rare occasions when it stains, indistinct.

The dimensions of an ovarian egg were: length of bulb, 0.12 mm.; width of bulb, 0.103 mm.; length of egg, 0.223 mm.; width of egg, 0.107 mm.; length of neck 0.107 mm.

Deposited egg.—The neck of the deposited egg passes through the scale's integument; contrary to the statements of Embleton and Thorpe, the bulb neither disappears nor breaks off but as a rule is merely collapsed and remains attached (fig. 32). The band on the main body of the egg becomes visible because of the silvery effect of the contained air. With small, nearly transparent hosts the band may be observed through the integument. The "conspicuous finely shagreened band" which Thorpe (1936) noticed on the empty chorion after eclosion was undoubtedly the acroscopic plate.

The band extends posteriorly to a point just short of the apex of the egg. The width is slightly irregular, but the widest points are at the anterior end. All along the central section there is an area of somewhat larger cells.

Soon after deposition a plug forms within the stalk near the egg proper becoming solid black. Thorpe and Embleton stated that this substance appears when the eggs are in the last stages of development within the ovaries. Thorpe considered the plug to be the remains of the "apical yolk mass."

Larva.—None of the larval stages described by Embleton was of the first stage. Thorpe has stated that the respiratory system of the first instar is metapneustic and that "the tenth post-cephalic segment of the body is prolonged in the form of two processes, each bearing a spiracle at the tip." I tend to question this observation even though my own was incomplete; my questioning is based on my own findings with *Encyrtus fuliginosus* and the figures presented by Thorpe. The first stage larva of *Encyrtus fuliginosus* is bluntly rounded at the caudal end. The processes on which the spiracles are to be borne appear in the next stadium. The head capsule of the larva illustrated by Thorpe (1936) is too large for the primary stage in comparison with those I have observed.

A single pair of spiracles is attached to the center of the band at its widest point near the stalk fig. 33, *A* and *B*). Thorpe observed the processes of later stages to be similarly fastened. The tracheal system is well developed, but many of the lateral branches of the tracheal trunks are not filled with air until some time after eclosion.

Encyrtus infidus (Rossi)

The life history of this scale parasite has been investigated by Silvestri (1919) and Clausen (1932). Although Clausen noted differences in the form and habit of the various stages and considered it probable that the species studied by Silvestri was not identical with that occurring in Japan, I do not consider the differences in the egg and first instar larva significant enough to warrant separate discussion.

Silvestri noted that the egg had a large and prominent band on the dorsum (fig. 15, left). At the distal end of the neck the band was brick-red, thickened, and spongy in appearance. The egg as described and drawn by Silvestri is quite different in several respects from the eggs I investigated in either

Encyrtus fuliginosus or *Encyrtus infelix*, in which the bands were found on the more convex (ventral) side of the egg, and the distal end of the necks was much more intricate in structure and had a projecting lip.

According to Silvestri, air is contained in the band when the egg is deposited. Undoubtedly Clausen observed the same phenomenon. He wrote: "on the dorsal side is what appears to be a waxy incrustation which extends from the base of the stalk to three-fourths the length of the main body. It is also found upon the stalk for its entire length, and in both the egg body and the stalk it covers approximately one-fourth the circumference."

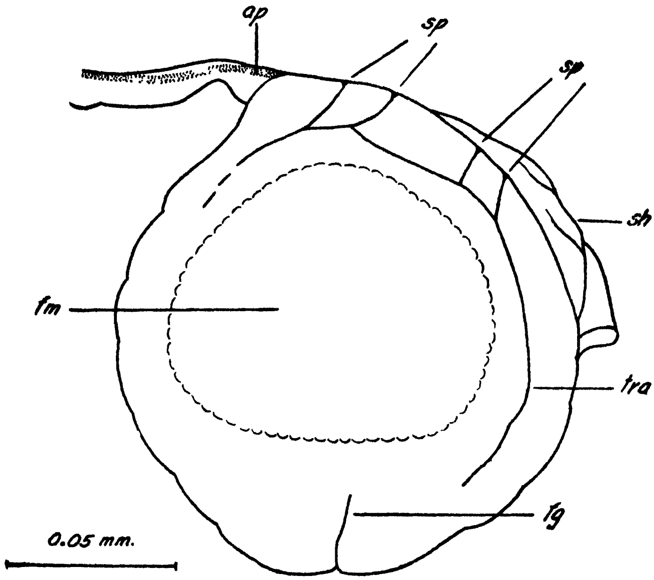

Fig. 39. *Erythraphycus argyrocomus* Comp. First instar larva shortly after eclosion. A large portion of the tracheal system has become invisible.

Silvestri (1919) and Clausen (1924) agree that after eclosion the newly hatched lerva remains partly encapsulated by the chorion of the egg (fig. 34). Silvestri observed that caudad the body is slightly bilobed and that to the posterior part of each lobe is applied a spiracle which adheres to the dorsal portion of the eggshell.

Encyrtus saśakii Ishii

Only the ovarian egg is described and illustrated by Ishii (1932). The thickness of the neck in the figure presented suggests a structure similar to that found on the eggs of other species of *Encyrtus*. If this proves to be the case, the early stages of this species will not be found to differ in any major respect from those of other species previously described.

Erythraphycus argyrocomus Comp.

The adult of this species is similar in general appearance to *Metaphycus howardi* and both attack the same host. This was the commoner species and material could be obtained at almost any time during the investigation.

Ovarian egg.—The only feature of the egg (fig. 35) worthy of note is the slight difference of the band; at no point does it surround the neck completely, and the width varies. On the egg proper the width is also variable and the cells are quite apparent, those at the anterior end being somewhat larger. The dimensions were: length of bulb, 0.188 mm.; width of bulb, 0.09 mm.; length of stalk, 0.103 mm.; length of egg, 0.18 mm.; width of egg, 0.111 mm.; length of band 0.137 mm.; width of band 0.034 mm.

Deposited egg.—The deposited egg (fig. 36) can be readily located by the presence of a ring of blackened material that has accumulated around the protruding stalk. (A similar ring of brownish material forms within the host.) The projecting portions of the egg do not extend vertically but are bent at an angle of 45° or more. The collapsed bulb remains attached. No plug forms within the stalk. The band eventually becomes slightly melanized from the point where the stalk enters the host to one-quarter of the length of the egg. The embryo develops with the head at the stalk end and apparently hatches from that position.

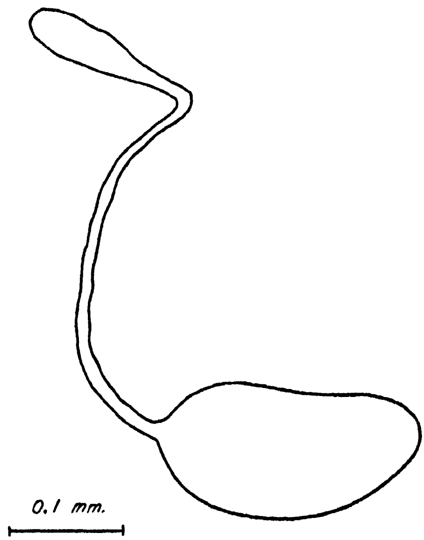

Fig. 40. *Eusemion californicum* Comp. Ovarian egg. The neck is usually more irregular in diameter and somewhat collapsed.

The first larva (fig. 39) is unusual. Instead of the usual simple pair of spiracles it possesses two pairs. It lies at right angles to the band and the four spiracles are placed along the longitudinal axis. In one larva the spiracles were in the center of the band. In other larvae they had shifted so that only one of the pairs was thus situated. Since the spiracles are not firmly attached, dissection probably caused them to alter their position. The band portion of the shell remains extended and straight whereas the remainder lies confusedly about the posterior section of the larva. At this stage of development the tracheal system is difficult to discern and little more than the spiracles and connecting tracheae are seen.

The tracheal system is readily discernible in the embryonic stages immediately prior to eclosion. Figures 36, 37, and 38 of unhatched eggs show the respiratory structures, which are filled with gas, yet the spiracles are not yet in contact with the band. Four spiracles, commissures, lateral tracheae, and secondary tracheae are clearly discernible. The larva of this species had two tracheal branches arising from the posterior commissure between the inner pair of spiracles.

Eusemion californicum Comp.

The ovarian egg (fig. 40) of this scale hyperparasite is large compared with those of many encyrtids. The bulb is not sharply differentiated from the neck and is not more than three times as broad. The length of the neck is nearly twice that of the egg. The egg proper is convex ventrally and somewhat concave dorsally. The measurements were: length of bulb, approximately 0.158 mm.; width of bulb, 0.038 mm.; length of neck, approximately 0.321 mm.; length of egg, 0.217 mm.; width of egg, 0.111 mm.

Compere (1925) observed that the deposited egg floated free within the body of the host. The long stalk, "the greater part of which was shriveled and functionless," remained attached. The larva lay free in the fluid contents of the primary larva. When newly hatched it had a tail appendage about one-third as long as the remainder of the larva. From Compere's drawing of the first instar larva it is apparent that the tracheal system is apneustic.

Eusemion cornigerum (Walker)

The egg of this secondary parasite was found by Timberlake (1913) to be deposited free within the body of the larva or pupa of its host. It was described as decidedly minute with only a short pedicel which is functionless after maturation and finally shrivels away. The development is apparently similar to that of *Cheiloneurus* and related secondary parasites in that the egg increases in size so that the newly hatched larva is many times the size of the freshly deposited egg.

The first instar larva has a conspicuous tail. No mention of the tracheal system was made by Timberlake, but it is undoubtedly apneustic.

Habrolepis dalmani (Westw.)

Gourlay (1935) described the larva as "attached to the body wall by a chitinized breathing tube." Although the eggs and larvae are not discussed in detail, it may be assumed that the structure of the stages follows the same pattern as with other encyrtids utilizing a "breathing tube." Another species also attacking scales, *Habrolepis rouxi,* is known to have a banded egg.

Isodromus iceryae How.

Clancy (1946) has given an extensive account of this parasite which attacks larvae of *Chrysopa.* The ovarian egg has no band. On the distal end of the neck Clancy noted a transparent colorless cone-shaped projection, somewhat similar in structure to collars on other eggs. Clancy was not able to assign any function to this structure.

Upon deposition a portion of the neck and the collapsed bulb are left extending beyond the surface of the host.

The newly hatched spherical larva remains weakly attached to the old eggshell by its posterior segments. In this instar spiracles are lacking.

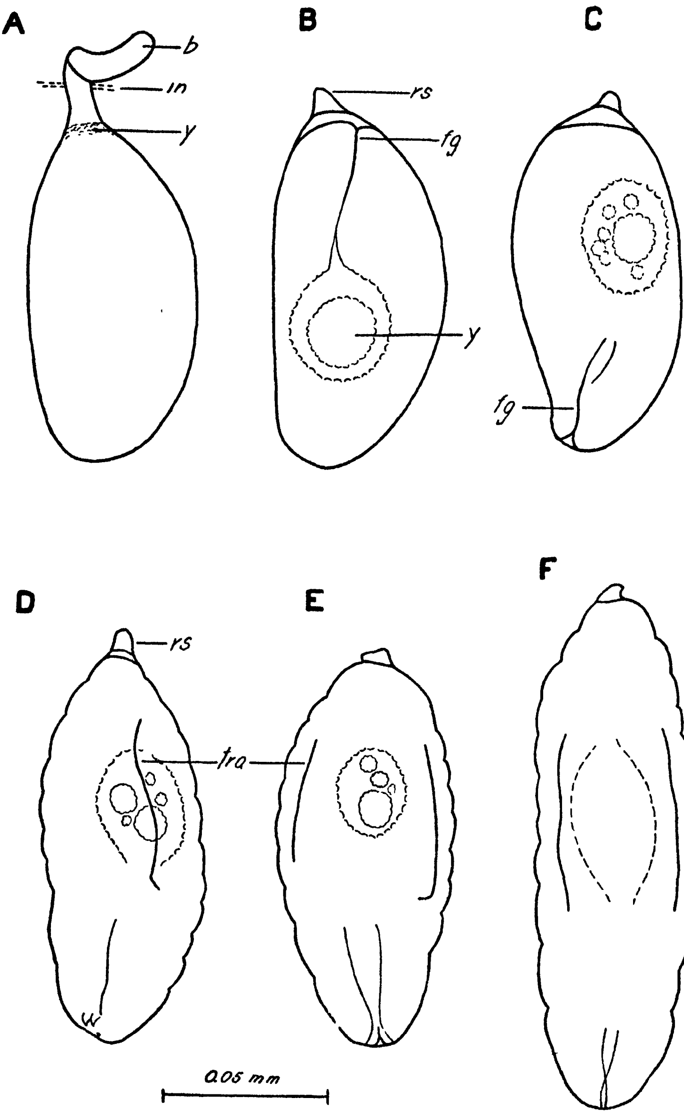

Fig. 41. *Leptomastidea abnormis* (Gir.). *A*, newly deposited egg; *B*, egg which has now become detached from the host's integument, showing developing embryo; *C*, same showing embryo in reserve position; *D, E,* and *F*, larva in progressive stages of growth, eclosion as yet incomplete.

Isodromus niger Ashm.

This parasite of *Chrysopa* larvae has also been thoroughly investigated by Clancy (1946) and was found to differ remarkably in the type of egg and larva from the other species of the genus on congeneric hosts. The ovarian egg has a well-defined band. In the deposited state the collapsed bulb and a portion of the neck project from the host's integument. The nearly spherical

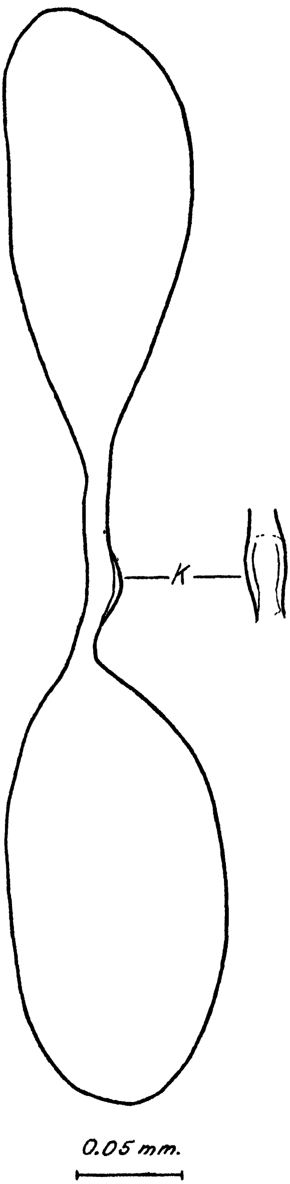

Fig. 42. *Melanaphycus fumipennis* (Timb.). Ovarian egg and dorsal view of neck.

first stage larva remains attached, its posterior segments contained within the eggshell and the single pair of spiracles in close opposition to the band.

Leptomastidea abnormis (Gir.)

Ovarian egg.—The ovarian egg (fig. 11) of this primary parasite of young citrus mealybugs (*Pseudococcus citri* Risso) is a little different in general shape from others in the Encyrtidae. With higher magnification and with the aid of stains it can be seen that the egg of this species differs in an important feature. On the neck just below the bulb (fig. 11, *D*) there is a cluster of approximately two dozen cells similar to those found in aeroscopic plates. This small elliptical group is the only indication of a band at any point on the egg.

The size of the egg is comparatively small. The measurements were: length of bulb, 0.12 mm.; width of bulb, 0.039 mm.; length of neck, 0.064 mm.; length of egg, 0.145 mm.; width of egg, 0.073 mm.

Deposited egg.—The egg in the deposited state (fig. 41, *A*) is also peculiar. Rather than being laid free in the body it is attached to the integument of the mealybug with the collapsed bulb and a portion of the neck protruding. The protruding stalk may be observed if the oviposition is watched or subsequently through staining. Shortly after deposition the protruding part is collapsed onto the sufrace of the host, and with the aid of stains it is barely noticeable as a small flat spot. If dissections are not made with enough caution immediately after oviposition, the main body of the egg becomes disengaged and floats free in the body contents of the host.

The embryo first lies with the head at the anterior end of the egg (fig. 41, *B*) but at completion of embryonic development the reverse position is assumed (*C*). Eclosion was not observed.

Larva.—The larva increases in size while still partly enclosed within the shell, for the stump of the detached stalk remains at the posterior end. (Fig. 41, *D, E, F.*) The chorion is eventually shed and the posterior segments become attenuated into a short tail.

The tracheal system which is usually most apparent in other species prior to eclosion and shortly thereafter is scarcely detectable. At no time were more

than three-fourths of the tracheal trunks visible and neither commissures nor tracheal branches could be seen. This may be due in part to the minuteness of the tracheae.

Melanaphycus fumipennis (Timb.)

Although this species attacks the same host as the two previous encyrtids, the structure of the early stages is entirely dissimilar.

Ovarian egg.—The ovarian egg (fig. 42) is extremely simple. Its sole distinctive feature is a slight swelling in the lower regions of the neck. The measurements were: length of bulb, 0.197 mm.; width of bulb, 0.077 mm.; length of neck, 0.086 mm.; length of eggs, 0.197 mm.; width of egg, 0.098 mm.

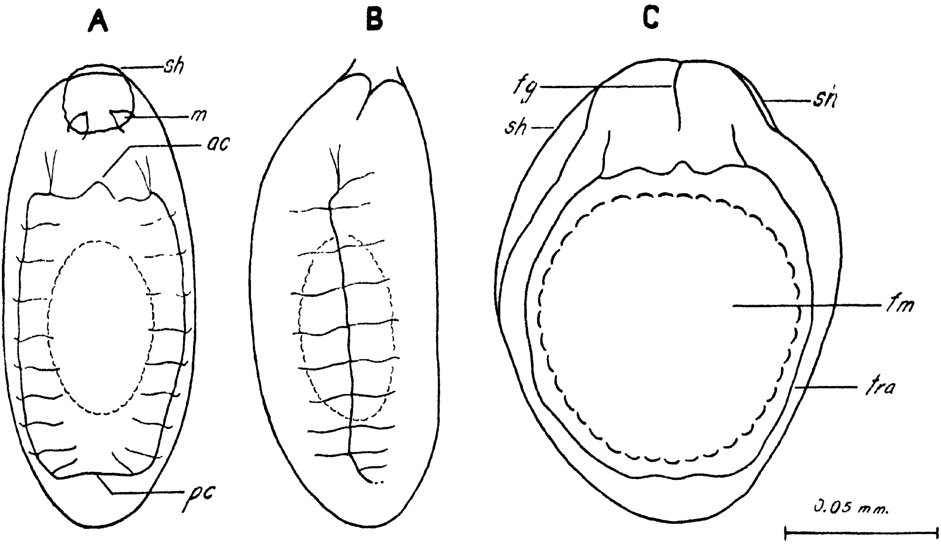

Fig. 43. *Melanaphycus fumipennis* (Timb.). *A* and *B*, two aspects of the mature embryo; *C*, larva. Apparently all the body but the head is enclosed by shell.

The deposited egg is attached to the integument of the host, this was ascertained only after repeated careful dissections of small hosts. The bulb and neck do not project as much as do those of banded eggs, but are more or less flattened to the integument. If several eggs are deposited in a group, which frequently happens, the stalks are more erect. A few hours after deposition that portion of the stalk within the host melanizes to a gray color which is visible through the host's derm.

The embryo develops with the head toward the stalk. The larva apparently hatches from this position, for larvae that had obviously fed retained the shell on most of the body (fig. 43, *C*). It is believed that the larval contortions break the connection with the stalk and the larva emerges by enlarging this rupture.

Larva.—The newly hatched larva floats freely within the host and when a host is dissected the parasite is seldom found near the stalk of the egg. At this state (fig. 43, *C*) it is almost a perfect sphere without the barest suggestion of segmentation and several times the larva appeared to be enclosed by shell.

The tracheae are very difficult to discern because of their minute size and the abundance of globules of food material. To trace them it was necessary to obtain eggs just prior to eclosion.

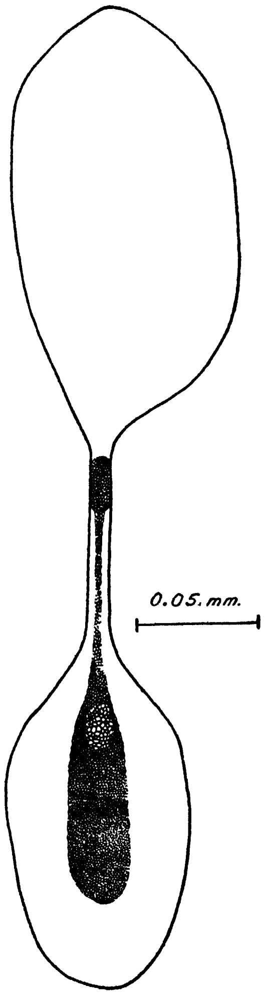

Fig. 44. *Metaphycus howardi* [Ckll.]. Dorsal view of ovarian egg.

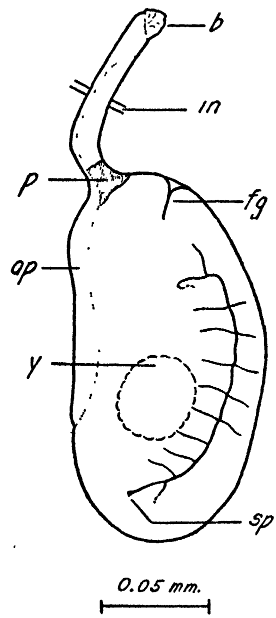

Fig. 45. *Metaphycus howardi* [Ckll.]. Deposited egg containing completely developed embryo.

Figure 43 (*A* and *B*) shows two views of unhatched eggs containing fully developed embryos. The tracheal system has no spiracles but the tracheae, commissures, and lateral branches are well developed.

Metaphycus alberti (How.)

References to this species were discovered among the unpublished notes of Harold Compere, who kindly lent them to me. No description is given of the eggs or larvae, but drawings of the egg indicate very definitely that a band is

present. According to these sketches the structure is similar to that found among other species of *Metaphycus*. The following dimensions were noted: length of bulb, 0.09 mm.; length of neck, 0.04 mm.; length of egg, 0.12 mm.

Metaphycus flammeus Comp.

One female of this species was obtained from *Lecanium quercitronis*. No host material in a suitable stage could be secured for studies of the development.

Although this is a close relative of *Metaphycus howardi*, its ovarian egg differs in structure. It is classed with the banded type (fig. 66, *A*). The band near the bulb end covers less than half the neck and immediately narrows to

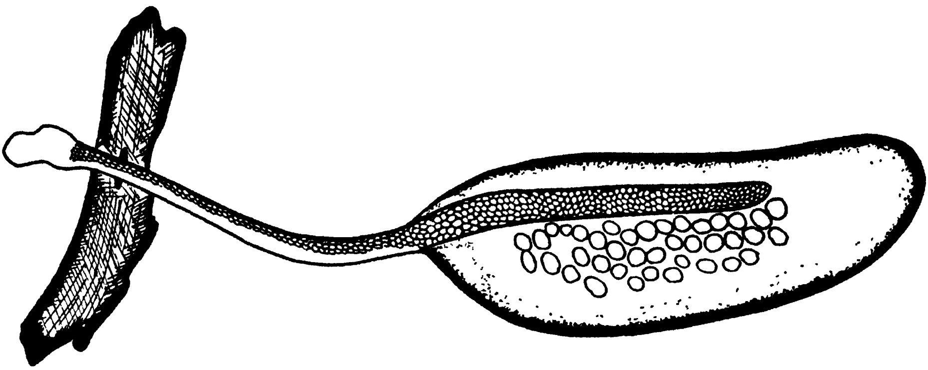

Fig. 46. *Metaphycus lounsburyi* (How.). Deposited egg. Note the distinct aeroscopic plate. (Redrawn from Smith and Compere, 1928.)

extend the length of the neck. On the egg proper the band widens somewhat, but is scarcely wider than the diameter of the neck. Cells are just barely distinguishable.

The measurements were: length of bulb, 0.137 mm.; width of bulb, 0.06 mm.; length of neck, 0.09 mm.; width of neck, 0.009 mm.; length of egg, 0.158 mm.; width of egg, 0.077 mm.

Metaphycus howardi [Ckll.]

This species was reared near Riverside, California, from material of an unknown species of *Eriococcus*. A few females were obtained for study from this same locality over a period of more than a year.

Ovarian egg.—The ovarian egg (fig. 44) differs in minor details from other banded eggs. The bulb is larger than the egg proper. The neck is not as long as the main body of the egg. The band toward the bulb end completely surrounds the neck. The remainder of the band on the neck is only three cells wide. On the egg proper the band widens and increases in width, although less abruptly, to its apex, a point about two-thirds the length of the egg. Most of the cells are very minute except in one central locality near the anterior end. The measurements were: length of bulb, 0.193 mm.; width of bulb, 0.094 mm.; length of neck, 0.086 mm.; length of egg, 0.137 mm.; width of egg, 0.081 mm.; length of band on egg, 0.103 mm.; width (maximum), 0.03 mm.

Deposited egg.—The deposited egg (fig. 45) is found attached to the integument of the host and is continuous with the projecting stalk. Before the larva has hatched, a yellowish brown plug has formed in the lumen of the stalk.

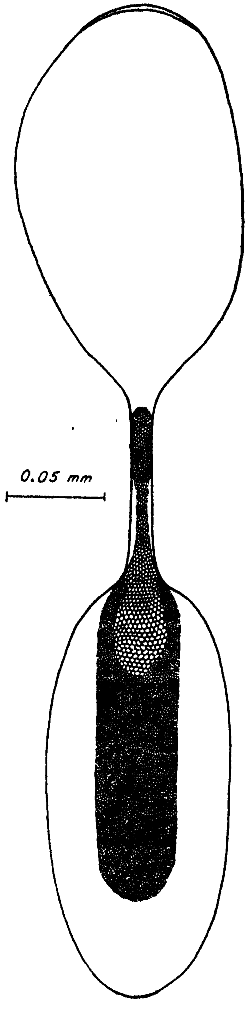

Fig. 47. *Metaphycus luteolus* (Timb.). Ovarian egg, dorsal view.

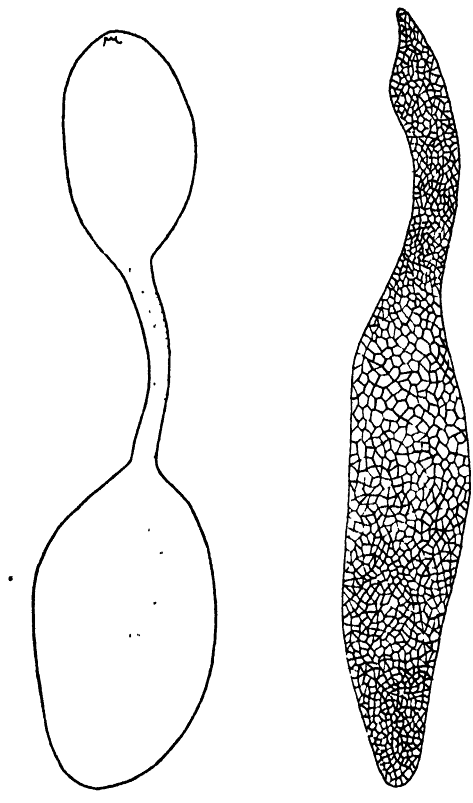

Fig. 48. *Metaphycus melanostomatus* (Timb.). Left, ovarian egg. Right, detail of the aeroscopic plate of the ovarian egg. (Redrawn from Silvestri, 1919.)

The fully developed embryo has been noted with its head near the stalk. Eclosion was not observed, but the midgut of one unhatched larva contained food materials, therefore showing that the larva had fed before eclosion and had not reversed. Quite possibly the larva perforates the shell with the mandibles, feeds, increases in size, and eventually bursts the shell.

Larva.—Difficulty in keeping parasitized hosts alive prevented observations on the larva, but it is apparent from the camera-lucida drawings of the

completely developed embryo (fig. 45) that a single pair of spiracles is to be found in the first instar larva.

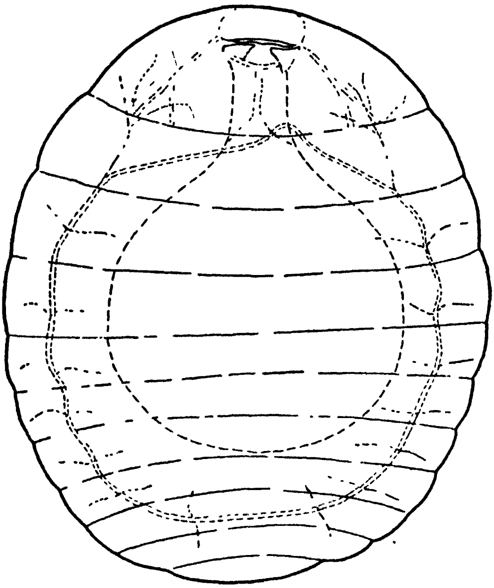

Fig. 49. *Metaphycus melanostomatus* (Timb.). First instar larva. (Redrawn from Silvestri, 1919.)

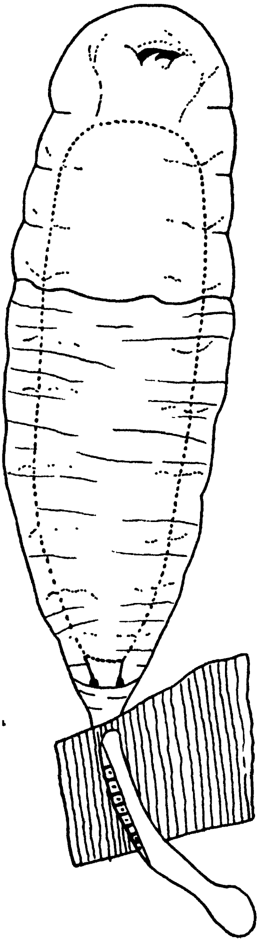

Fig. 50. *Microterys ferrugineus* (Nees). First stage larva. The figured neck indicates that a band is found with this species. (Redrawn from Parker and Thompson, 1925.)

Metaphycus lounsburyi (How.)

The biology and habits of this primary parasite of *Saissetia oleae* (Bern.) have been described in detail by Smith and Compere (1920, 1928). I observed the ovarian egg only.

Ovarian egg.—The ovarian egg is similar to that of *Metaphycus luteolus,* but the band on the egg proper is somewhat narrower and more wedge-shaped, being widest toward the neck. The cells are of moderate size and uniform except at the distal end where they are slightly larger. The large cells are not

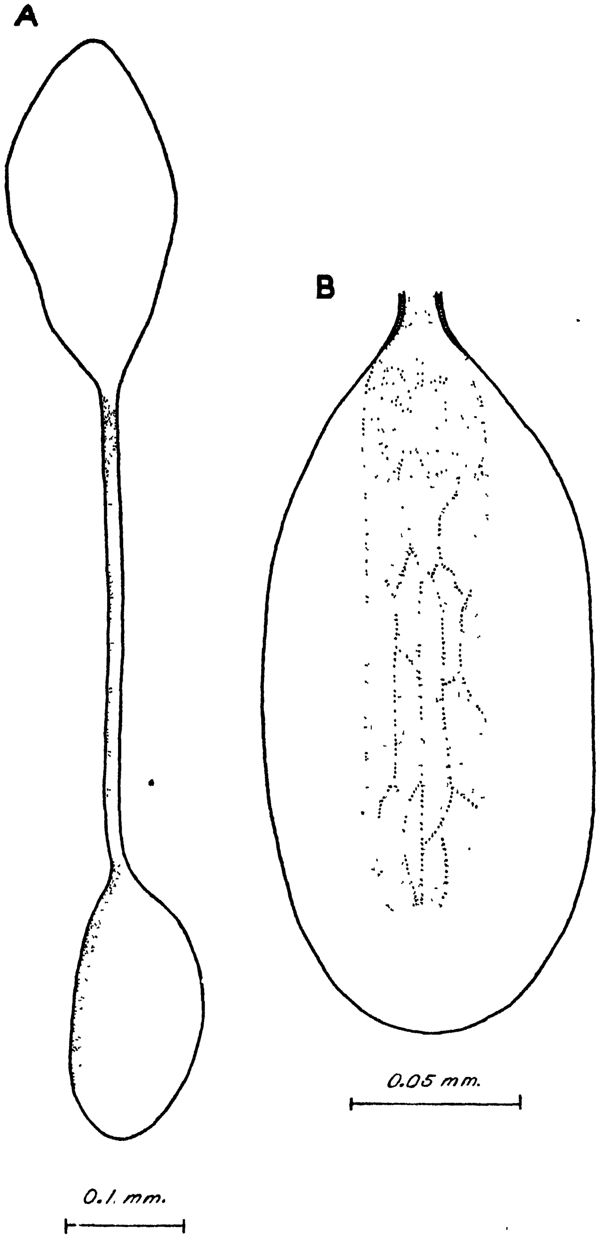

Fig. 51. *Microterys flavus* (How.). *A*, ovarian egg; *B*, dorsal aspect of egg proper, showing detail of aeroscopic plate. Larger cells from pattern.

in a demarcated area as in *M. luteolus* eggs, but gradually become mixed with the more minute cells in the sourrounding regions. Measurements were: length of bulb, 0.201 mm. width of bulb, 0.09 mm.; length of neck, 0.128 mm.; width of neck, 0.013 mm.; length of egg body, 0.218 mm.; width of egg body, 0.094 mm.; length of band on egg body, 0.154 mm.

Deposited egg.—Smith and Compere (1928) found the newly deposited egg to be stalked. Beyond a doubt the band was observed but was not recognized as such. They described a "ventral rib or stay" which extended about two-thirds the length of the egg body and which became dense white immediately after deposition. The drawing (see fig. 46) of the deposited egg shows this "ventral rib" clearly.

Larva.—The first instar larva was described by Smith and Compere.[7] Upon hatching it remains with the posterior five of the thirteen body segments enclosed by the eggshell. The tracheal system is metapneustic.

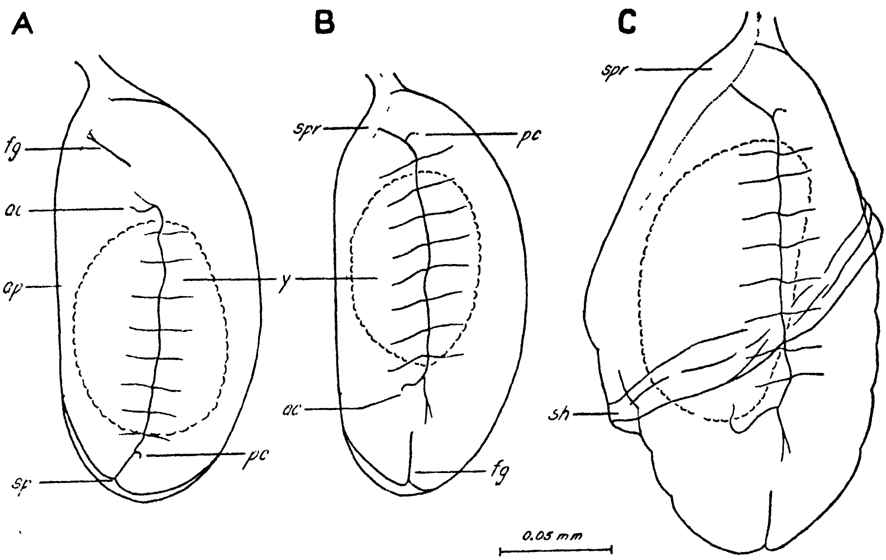

Fig. 52. *Microterys flavus* (How.). *A*, fully developed embryo prior to reversal; *B*, the same embryo after reversal, the eggshell intact; *C*, first instar larva immediately after eclosion.

Metaphycus luteolus (Timb.)

The ovarian egg (fig. 47) is very large compared with the size of the female and only a few eggs are matured at any one time. The egg is banded. Near the bulb the band extends nearly around the neck but more abruptly recedes until near the anterior end of the egg proper, where it commences to broaden. On the egg proper it is uniform in width. Most of the cells are minute, but at the end toward the neck there is a differentiated area of much larger cells. From a lateral aspect these cells appear noticeably thicker than those of the remainder of the band. The measurements were: length of bulb, 0.188 mm.; width of bulb, 0.103 mm.; length of neck, 0.086 mm.; length of egg, 0.18 mm.; width of egg, 0.093 mm.; length of band on egg proper, 0.137 mm.; width of band, 0.043 mm.

[7] The figure of the first instar larva in the earlier paper is probably actually the second instar as evidenced by the comparative size of the larva and eggshell, as well as the greater diameter and degree of development of the tracheae.

Neither deposited eggs nor larvae were examined. Smith and Compere (1928) report the egg to be suspended by the stalk from the dorsum of the host scale, but do not describe the larva. The larva will probably be found to have a metapneustic tracheal system in the first instar.

Metaphycus melanostomatus (Timb.)

Both Imms (1918) and Silvestri (1919) have investigated the development of this European species, which is parasitic on scale insects. Silvestri described the various stages as those of *Aphycus punctipes* (Dalm.) and considered *Metaphycus melanostomatus* as synonymous. Imms also synonymized the former with the latter. According to P. H. Timberlake, these are distinct species and both Silvestri and Imms undoubtedly dealt with *Metaphycus melanostomatus* and not *Aphycus punctipes*.

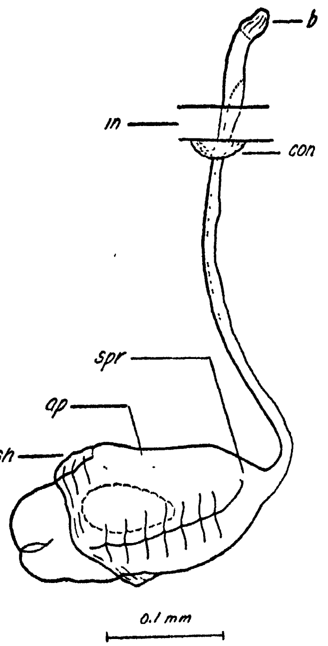

Fig. 53. *Microterys flavus* (How.). Newly hatched larva suspended by the remains of the eggshell attached to the integument of the host. The neck, with the exception of the part bearing the band, is collapsed.

According to Silvestri the ovarian egg is similar in form to that of *Blastothrix sericea* only somewhat smaller. No respiratory band is described, yet the figures and legend indicate that a distinct band was observed (fig. 48).

Silvestri found the deposited egg to be attached to the integument with the petiole projecting to the exterior of the host. Imms, on the other hand, reported the egg to lie free in the body cavity and to be devoid of a petiole. It is of some significance that Silvestri also found a band on the egg of *Blastothrix sericea,* whereas Imms failed to record one on the egg of supposedly the same species.

In the main, both workers agree regarding the structural details of the newly hatched larva: the tracheal system being simple and apneustic, consisting only of two main tracheal trunks, anterior and posterior commissures, and a single cephalic branch on either side (fig. 49). But Silvestri reported the newly hatched larva as being posteriorly encapsulated by the eggshell which was suspended from the host's integument. Imms records no such relationship.

If Silvestri's evidence is accepted, the larva of this species constitutes the single exception to the statement that with species of encyrtids having banded eggs the early larval stages have metapneustic tracheal systems. In view of the confusion in the taxonomy and the variations of the findings of the two investigators, further examination seems warranted.

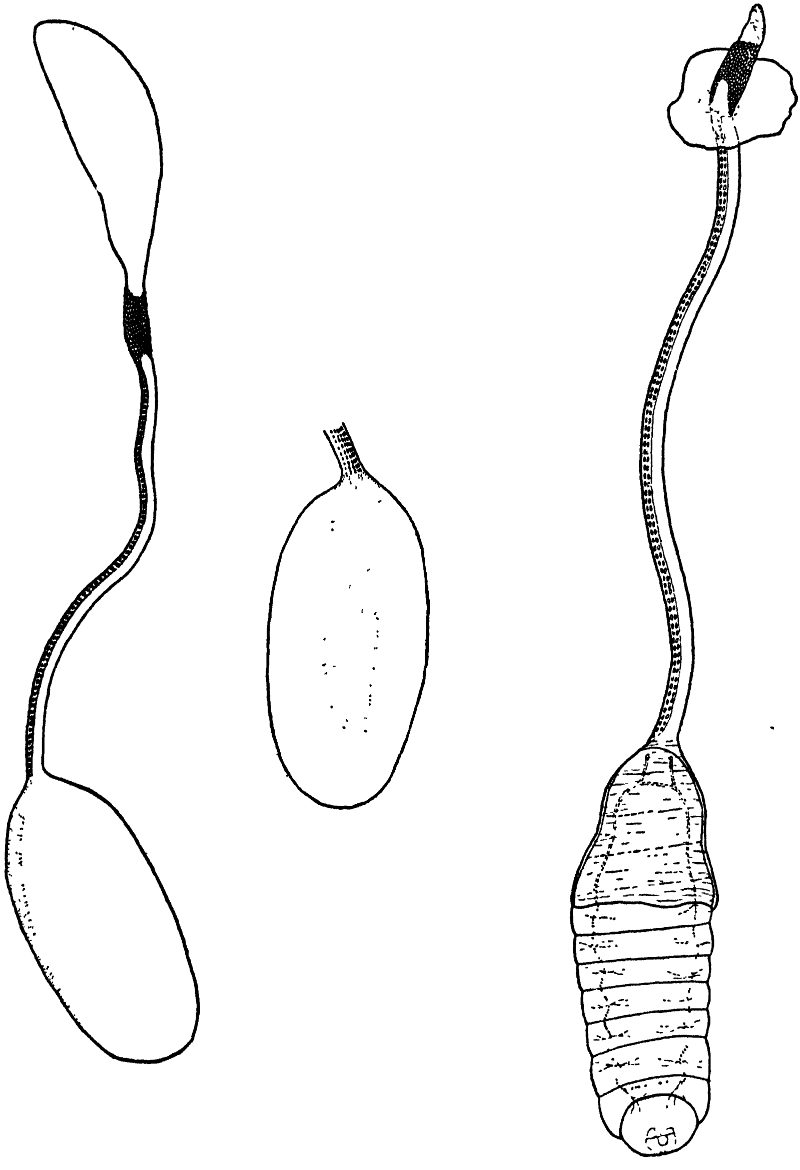

Fig. 54. *Microterys masii* Silv. Left, ovarian egg. Center, posterior portion of the same. Right, newly hatched larva suspended by the petiole attached to the host's integument. (Redrawn from Silvestri, 1919.)

Metaphycus timberlakei (Ishii)

The type of egg is not apparent from the descriptions of Ishii (1932), nor does he state whether the deposited egg is attached or free. The larva figured is nearly identical in shape and structure with the first instar larva of *Metaphycus melanostomatus*. The body is nearly as wide and long. The tracheae

form a complete loop with one cephalic branch on either side. Spiracles are evidently lacking.

Microterys clauseni Comp.

An illustration by Ishii (1932) of the deposited eggs shows that it is of the banded type. In this drawing the stalks of the eggs are covered with a minute network which no doubt represents the cells of a band.

Microterys ferrugineus (Nees)

In addition to summarizing the available information on the egg and larva of encyrtids, Parker (1924), in his well-known work on the postembryonic forms of Chalcids, described the larva of this scale parasite.

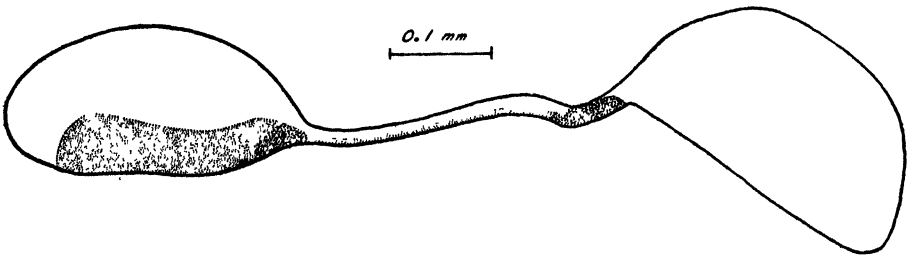

Fig. 55. *Microterys saissetiae* Comp. Ovarian egg, lateral view.

The newly hatched larva remains with the posterior part of the abdomen sheathed by the eggshell which is attached by the pedicel to the integument of the host. The tracheal system is metapneustic. No band structure was described or drawn. In a later paper by Parker and Thompson (1925) there was presented a figure of the sheathed larva which suggests that a band was observed (see fig. 50).

Microterys flavus (How.)

Timberlake (1913) has made observations on this, a parasite of soft brown scale (*Coccus hesperidum* Linn.). I was able to confirm and enlarge his report on the egg and larva.

Ovarian egg.—The ovarian egg (fig. 51, *A*) is distinctive in that its neck is more than twice as long as the main body. Timberlake did not observe the prominent band. Most of the cells are minute but larger cells form a network presenting an appearance similar to that shown in figure 48, *B*. The measurements were as follows: length of bulb, 0.3 mm.; width of bulb, 0.15 mm.; length of neck, 0.428 mm.; width of neck, 0.013 mm.; length of egg, 0.227 mm.; width of egg, 0.107 mm.

Deposited egg.—The egg is attached to the integument and the collapsed bulb and a portion of the neck protrude. The band is silvery throughout and immediately apparent after deposition. The stalk is curved so that the main body lies parallel to the host's integument. Just below the integument there is an agglomeration of melanized host material. The stalk also becomes melanized by the time the larva hatches. The distal half becomes yellow and proximal half brown.

The embryo develops with the head at the stalk end (fig. 52, *A*). (One embryo reversed its position prior to eclosion.) Immediately following this phase of development the embryo proceeds to expand and squirm until the eggshell is finally split to wrinkle backward over the body.

Larva.—Timberlake did not describe the tracheal system of the first instar larva. The existance of an open system was implièd in the statement that the egg stalk was strictly homologous and similar to that of *Ooencyrtus kuvanae,* the function of which had been described as respiratory.

Figures 52, *C,* and 53 show the newly hatched larva. The tracheal system does not deviate from the general plan of metapneustic encyrtid larva. The posterior commissure is short and straight, whereas the anterior one is more than twice as long and arches over the foregut. Lateral branches are readily distinguishable. The spiracles are placed on the band so that each lies at a point one-third the distance from the margin of the band.

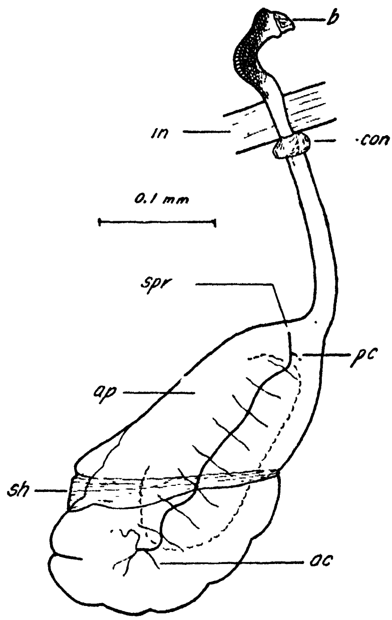

Fig. 56. *Microterys saissetiae* Comp. Newly hatched larva suspended by the eggshell attached to the integument of the host.

Microterys masii Silv.

Silvestri (1919) stated that the egg of this species is similar to that of *Phaenodiscus aeneus,* but had a shorter neck. The stage is not described in detail. From his drawings it is apparent that a band is present (see fig. 54).

The deposited egg and first instar larva are also similar to those of *Phaenodiscus.* Although the respiratory system of the larva is metapneustic, in Silvestri's drawings of the newly hatched larva the spiracles do not appear to have any relation to the band.

Microterys saissctiae Comp.

This parasite of black scale (*Saissetia oleae* Bern.) was introduced into California by Harold Compere. A limited amount of material for study was made available during its propagation.

Ovarian egg.—The egg of this species (fig. 55) resembles in certain respects the eggs of other *Microterys* and that of *Coccidoxenus niloticus.* It resembles the former in the length of the neck which is slightly longer than the main body of the egg. The band has the general shape and structure found in *Coccidoxenus.* The anterior of the neck is similarly ornamented, consisting of a network of four-sided or three-sided cells with slight thicknesses at the corners, as illustrated in the drawing (fig. 28, *A*). Unlike *Coccidoxenus,* there is no pattern on the band of the egg proper made by larger cells. The measure-

ments were approximately as follows: width of bulb, 0.16 mm.; length of bulb, 0.3 mm.; length of neck, 0.32 mm.; width of egg, 0.14 mm.; length of egg, 0.31 mm.; width of band (maximum) 0.11 mm.

Deposited egg.—The egg in the deposited state is of the stalked type with the anterior extremity of the neck and the collapsed bulb protruding from the host's integument. The projecting neck is rigidly curved so that a definite hook is formed. The stalk soon becomes melanized throughout its length with the exception of the exterior portion. A black mass of host material congregates around the stalk immediately below the integument. The embryo evidently

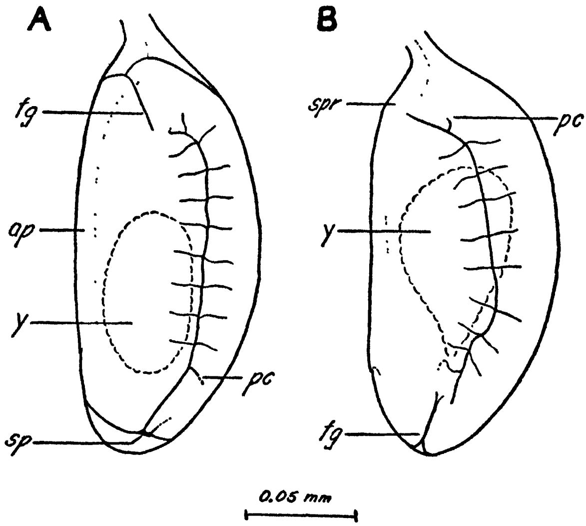

Fig. 57. *Ooencyrtus californicus* Gir. *A*, mature embryo prior to reversal; *B*, after reversal.

develops with the anterior end near the stalk, although this was observed only once. Lack of material prevented additional observations.

Larva.—The larva (fig. 56) differs in no particular detail from the newly hatched larva of *Coccidoxenus.* The single pair of spiracles is located near the stalk but, unlike *Coccidoxenus,* retains the same general position in the later instars.

Microterys speciosus Ishii

Ishii (1932) has given an extensive account of this encyrtid. The ovarian egg appears to be similar to that of most *Microterys* in that the neck is long and slender. There is no indication in the description or drawings of the presence of a band although the function of the pedicel was described as respiratory. In a later publication Ishii (1932) remarked that the chorion is minutely reticulated, which may indicate the presence of a band. The deposited egg is attached to the integument of the host scale and a portion of it protrudes. After eclosion the larva remains with the caudal five segments enclosed by the eggshell. The tracheal system is metapneustic.

Ooencyrtus californicus Gir.

Material for study was secured from an infestation of *Anasa tristis* De Geer at Riverside, California.

The undeposited egg is remarkably similar to that of *Ooencyrtus johnsoni.* The structure of the band on the neck is identical with *O. johnsoni,* but the division at the apex of the band on the egg body is not so prominent, and the band is slightly wider relative to the size of the egg. The dimensions were: length of bulb, 0.188 mm.; width of bulb, 0.068 mm.; lenkth of neck, approximately 0.377 mm.; length of egg, 0.180 mm.; width of egg, 0.094 mm.; length of band on egg, 0.150 mm.

The deposited egg lacks distinguishing features. The development parallels that described for *Ooencyrtus johnsoni.* Figure 57 shows an unhatched larva prior to reversal (*A*) and after reversal (*B*). The larval (fig. 58) respiratory systems are alike.

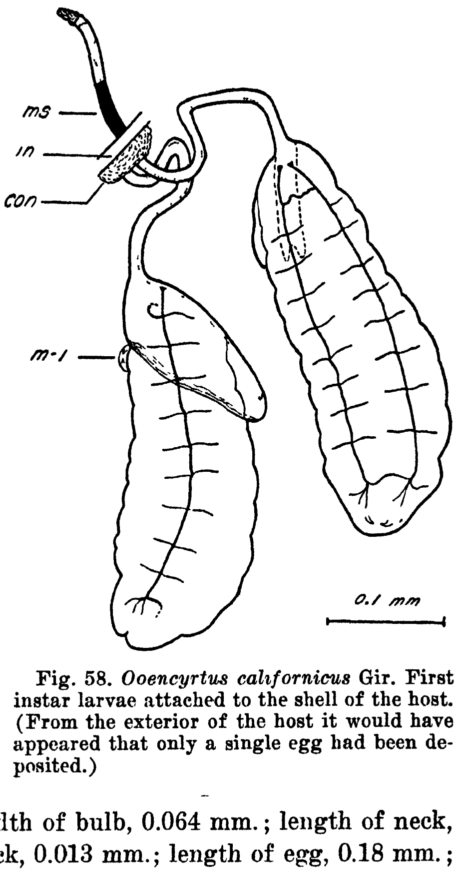

Fig. 58. *Ooencyrtus californicus* Gir. First instar larvae attached to the shell of the host. (From the exterior of the host it would have appeared that only a single egg had been deposited.)

Ooencyrtus johnsoni (How.)

The eggs of the harlequin cabbage bug, *Murgantia histrionica* (Hahn), are commonly attacked by this encyrtid in southern California.

Ovarian egg.—The ovarian egg (fig. 59, *A*) is quite large and its neck is half again as long as the main body of the egg. The bulb is smaller than the egg proper and its apex is slightly thickened. Measurements were: length of bulb, 0.158 mm.; width of bulb, 0.064 mm.; length of neck, approximately 0.3 mm.; width of neck, 0.013 mm.; length of egg, 0.18 mm.; width of egg, approximately 0.09 mm.

A distinct band is present which, in certain respects, differs from those of all encyrtid eggs but those of another species of *Ooencyrtus*. The most striking variation is in the appearance of the band on the main body (fig. 60). The marginal areas are composed of minute cells. At the center of the anterior end the cells are large and contiguous, then abruptly become scattered throughout the central section. The band is irregular in breadth and at the apex is divided into two short prongs composed of thick cells. The length measures 0.15 mm. and the greatest width is approximately 0.03 mm.

An additional structure, either nonexistent or obscure in most eggs, is noted

at the apex of the neck (fig. 59, *B* and *C*). At that point the cells completely surround the neck, and as the band narrows the cells underlie a thickened wall for nearly 0.1 mm. The wall may cover the rest of the neck and the upper part of the main body. Frequently it appeared that the band was situated under a thin layer at the junction of the neck with the egg, although this may be a microscope effect.

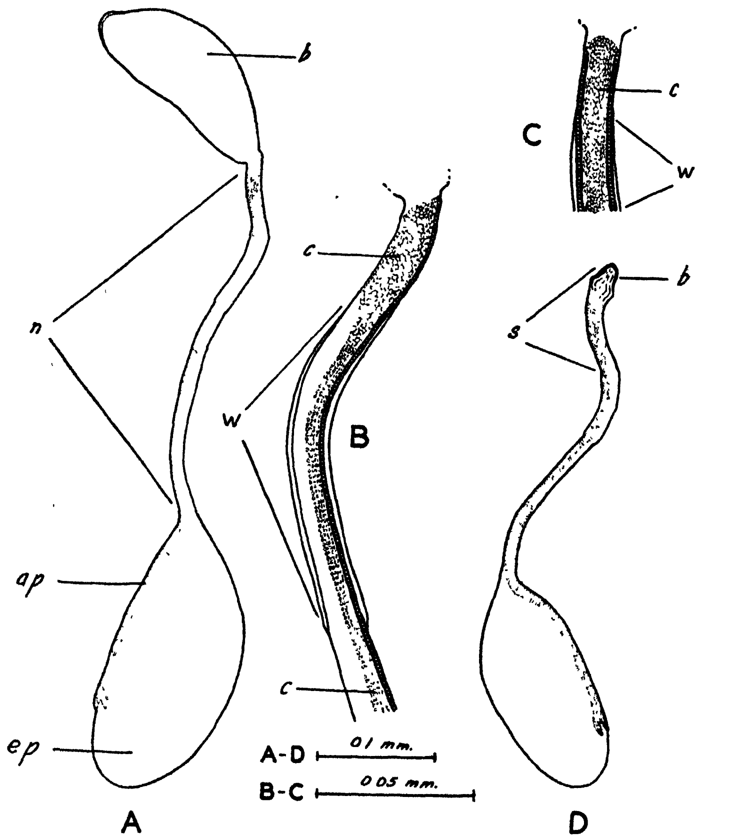

Fig. 59. *Ooencyrtus johnsoni* (How.). *A,* ovarian egg. *B,* lateral aspect of anterior section of the neck. The band passes beneath a thickened wall. *C,* dorsal dorsal view of the bulb end. *D,* deposited egg.

Deposited egg.— In the process of oviposition the contents of the bulb are forced into the egg proper and the remains of the bulb are left attached to the protruding neck, as shown in figure 59, *D*). The thickened end fits over the neck like a cap.

Usually the chorion of the host egg surrounds that portion of the neck which has thickened walls. Eggs may be deposited singly or in groups of two or three.

Melanization commences soon after deposition. The thickened portion of the neck becomes blackened even though all or part lies outside the host. Throughout the neck and upper part of the egg body the band becomes brown.

The embryo first lies with its head at the anterior end, as shown in figure 61, *A* (p. 108), and later reverses itself (*B* and *C*).

Larva.—At eclosion the eggshell ruptures and wrinkles about the posterior of the larva, the band remaining fairly straight and unbroken; two spiracles are affixed to it near the stalk. Lateral tracheal branches are very minute and difficult to discern. Figure 61, *D,* shows a larva that has just hatched. The larva remains attached in a similar manner during most of its existence.

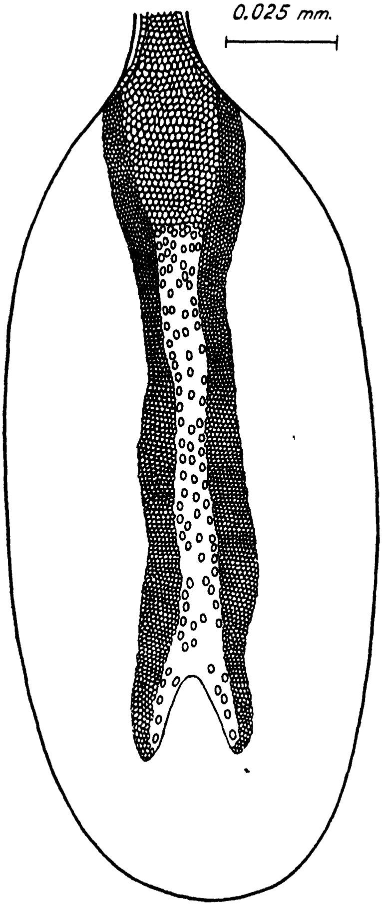

Fig. 60. *Ooencyrtus johnsoni* (How.). Dorsal aspect of egg proper, showing detail of band.

Ooencyrtus kuvanae (How.)

The investigation of this species reported by Howard and Fiske (1911) has been the standard reference in many subsequent articles on encyrtid biologies. Theirs was the first report of the so-called "stalked eggs." However, they erred in interpreting the function of the stalk and their error has frequently appeared in subsequent writings. By means of preserved parasitized host material and live adult parasites kindly supplied by R. C. Brown of the U. S. Department of Agriculture, Forest Entomological Laboratory at New Haven, Conn., I have been able to correct and amplify some of the description by Howard and Fiske.

Ovarian egg.—The ovarian egg resembles that of other species of *Ooencyrtus* described here, having the same general shape but a different structure. Near the bulb the neck is broader; the increased breadth continues for a short distance, thence the neck becomes uniformly narrow. It is possible that this bulge may serve to retain a portion of the egg protruding from the host.

The band on the egg proper differs as well. The general shape—broad at the distal end, narrower toward the center, then broad again—is the same. But the cells are small except for an ovoid area occupying most of the anterior end. They are sparse only near the center of the slightly bifurcate apex. The cells here are no thicker than others. Those on the neck do not appear to have thickened walls. The cells surround the neck immediately above the bulge and some of these are slightly larger than the others.

Deposited eggs.—In all the preserved material examined the end of the stalk protruded from the host's eggshell. Where the host embyro was com-

pletely formed, the egg was found within the body cavity in the same manner as described and drawn by Howard and Fiske. The portion of the egg protruding from the host egg consists of the anterior portion of the neck and the col-

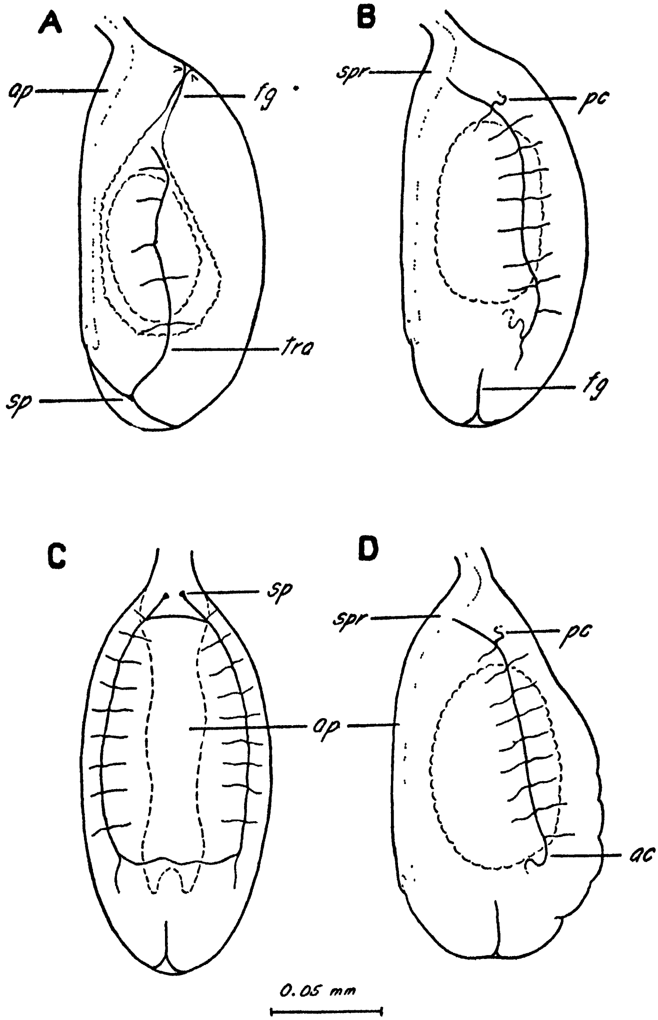

Fig. 61. *Ooencyrtus johnsoni* (How.). *A*, mature embryo prior to rotation; *B* and *C*, two aspects of embryo subsequent to reversal; *D*, newly hatched larva.

lapsed bulb. Even though the material had been preserved in Bouin's fixative, the silvery sheen resulting from the presence of air within the band was frequently observable.

Larva.—Satisfactory material was unfortunately not obtainable for observations of the larva. As with others of this type, the larva remains with the posterior end enclosed by the eggshell. Although *Ooencyrtus kuvanae* has been repeatedly referred to as remarkable in that the larva respires through a tube, the existance of spiracles was not demonstrated until recently, when

Parker (1933) noted two open spiracles at the point of attachment to the eggshell. An observation by Howard and Fiske appears open to question. They report the stalk to increase in thickness as the larva grows. Since the egg stalk consists solely of shell it is not conceivable that it is capable of growth of itself. Among those which I observed, none increased in thickness. The mela-

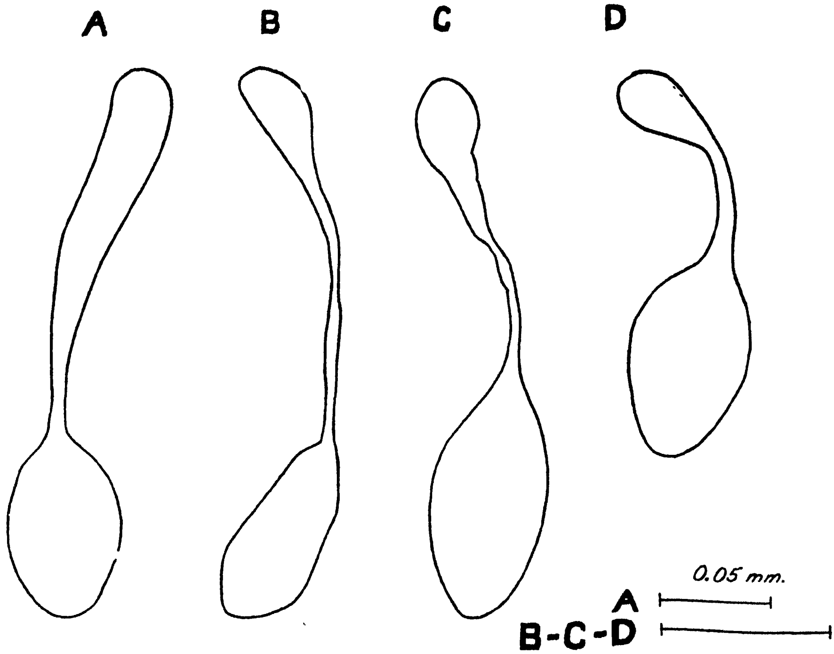

Fig. 62. Ovarian eggs of: *A, Acerophagus pallidus* Timb.; *B, Acerophagus fasciipennis* Timb.; *C, Stemmatosteres apterus* Timb.; *D, Paralitomastix pyralidis* (Ashm.).

nization of the stalk as development proceeds does cause the stalk to appear more prominent and it is therefore quite possible that it created an illusion of greater thickness.

Paralitomastix pyralidis (Ashm.)

Although no investigation of the eggs and larvae of polyembryonic encyrtids was made in this work, the ovarian egg of this species was examined for purposes of comparison.

The egg (fig. 62, *D*) is extremely simple, small, and its shell is unmodified. The bulb is short and only slightly wider than the neck. The egg proper is elliptical, the anterior end being the broader. The apex is somewhat more pointed than in other eggs. The measurements were: length of bulb and neck, 0.072 mm.; maximum width of bulb and neck, 0.017 mm.; length of egg, 0.06 mm.; width of egg, 0.034 mm.

It is evident from the literature on polyembryonic species (see especially Silvestri, 1908, *et seq.*) that the egg is deposited entirely within the host and that the larvae that develop do not possess spiracles in the primary stages.

Phaenodiscus aeneus (Dalm.)

Silvestri (1919) has given a detailed description of the developmental stages which is well supported by drawings, three of which are duplicated in figures 63 and 16. The neck of the egg is nearly four times as long as the main body. The band on the egg is minutely "dimpled" and extends from the bulb nearly to the apex of the egg. At the bulb end the neck is slightly larger and at this point the band extends completely around. This portion remains exterior to the host and was termed by Silvestri the "respiratory plug." The egg is deposited with the anterior body and a part of the connecting tube remaining outside the host integument as in other stalked eggs. The newly hatched larva retains the last few abdominal segments within the egg-shell. The single pair of posterior spiracles adheres to the aeroscopic plate.

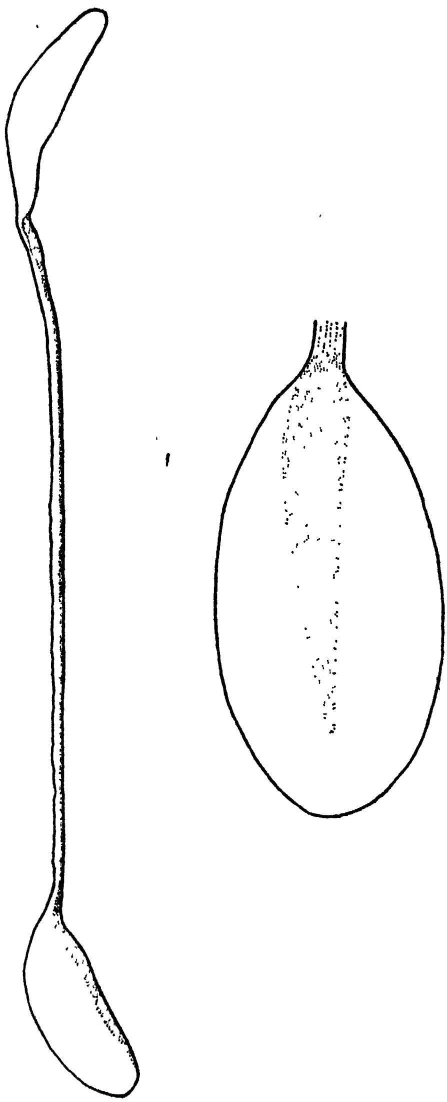

Fig. 63. *Phaenodiscus aeneus* (Dalm.). Left, ovarian egg. Right, posterior portion of same. (Redrawn from Silvestri, 1919.)

Pseudaphycus angelicus (How.)

This is a parasite of the Mexican mealybug, *Phenacoccus gossypii* Twns. and Ckll., and several other mealybug species in southern California.

Ovarian egg.—The undeposited egg (fig. 64, *A*) is extremely simple in structure, lacking any suggestion of a band or any modification of the chorion. The bulb is long and narrow and not sharply differentiated from the neck. The egg when compressed is convex on the ventral side and nearly straight on the dorsal. The measurements were: length of bulb and neck, 0.312 mm., approximately; maximum width of bulb, 0.051 mm.; length of egg, 0.175 mm.; width of egg, 0.098 mm.

Deposited egg.—The deposited egg (fig. 65, *A*) lies entirely within the host. A portion of the neck and the collapsed bulb are doubled back over the basal

portion of the neck and become melanized soon after deposition of the egg. In some specimens a crumpled mass of material was observed at the proximal end of the neck.

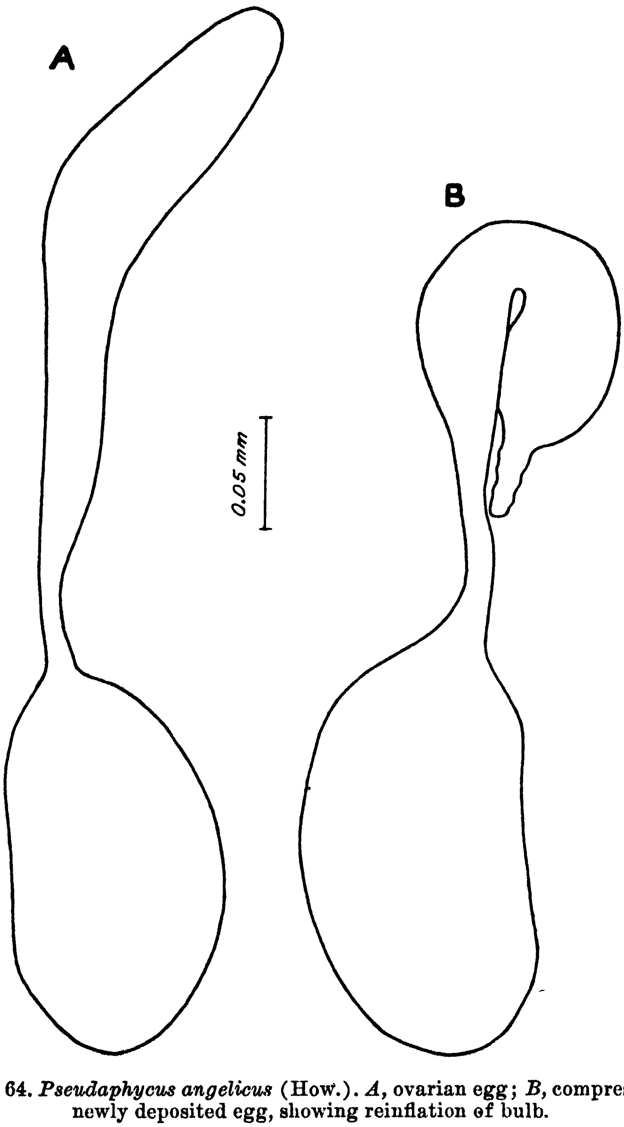

Fig. 64. *Pseudaphycus angelicus* (How.). *A*, ovarian egg; *B*, compressed newly deposited egg, showing reinflation of bulb.

Larva.—No trace of a tracheal system could be seen in either the completely developed embryo or the first instar larva. Usually the tracheal structures are most easily discernible in the embryo. Figure 65 shows a fully developed embryo, *A*, and a first instar larva, *B*. The larva had obviously fed, yet the small circle around the mandibular region suggests that most of the larval body is still enclosed by the shell. Although tracheae may be present and extremely minute, spiracles are undoubtedly absent.

Pseudleptomastix squammulata Gir.

This encyrtid is the parasite most frequently obtained in southern California from *Amonostherium lichtensioides* Ckll., a coccid common on *Artemisia californica.* Lack of suitable material prevented satisfactory observations of the larva. The same species was found to attack *Pseudococcus maritimus* by Clausen (1924) who was successful in investigating all stages.

The ovarian egg is banded (fig. 66, *B*) and in general resembles most other eggs of the type. At the bulb end of the neck the band is broad and composed

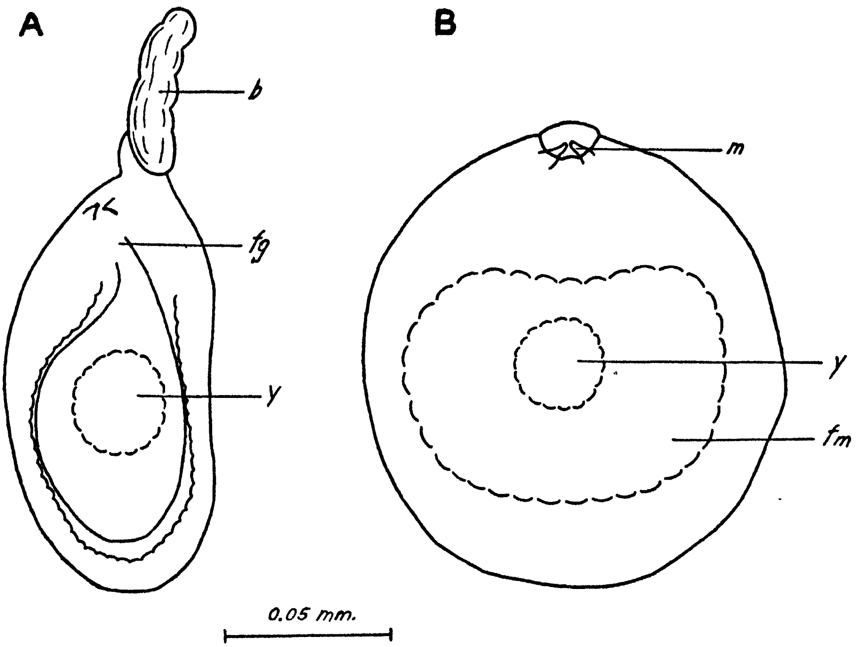

Fig. 65. *Pseudaphycus angelicus* (How.). *A,* deposited egg containing fully developed embryo; *B,* first instar larva. Almost the entire body is enveloped in shell.

of prominent cells arranged in much the same pattern as in *Anagyrus putonophilus;* it then abruptly narrows to a breadth of two cells, and on the main body of the egg broadens again until it is slightly wider than the neck although nevertheless narrow compared with the band on most eggs. Clausen does not indicate that he saw a band.

The measurements were: width of bulb, 0.042 mm.; length of bulb, 0.163 mm.; width of egg, 0.06 mm.; length of egg, 0.146 mm.; length of neck, 0.107 mm.

On *Amonostherium* the eggs are deposited singly or in groups of two and three protruding from the same aperture. The swollen portion of the neck protrudes from the host's integument. According to Clausen, single eggs are laid in *Pseudococcus maritimus* in the same manner.

I was not able to observe the larva; however, Clausen noted that the young

larva remains attached at its anal end to the stalk, "the function of which has been described as respiratory." The type of tracheal system was not specified, but it is probably metapneustic.

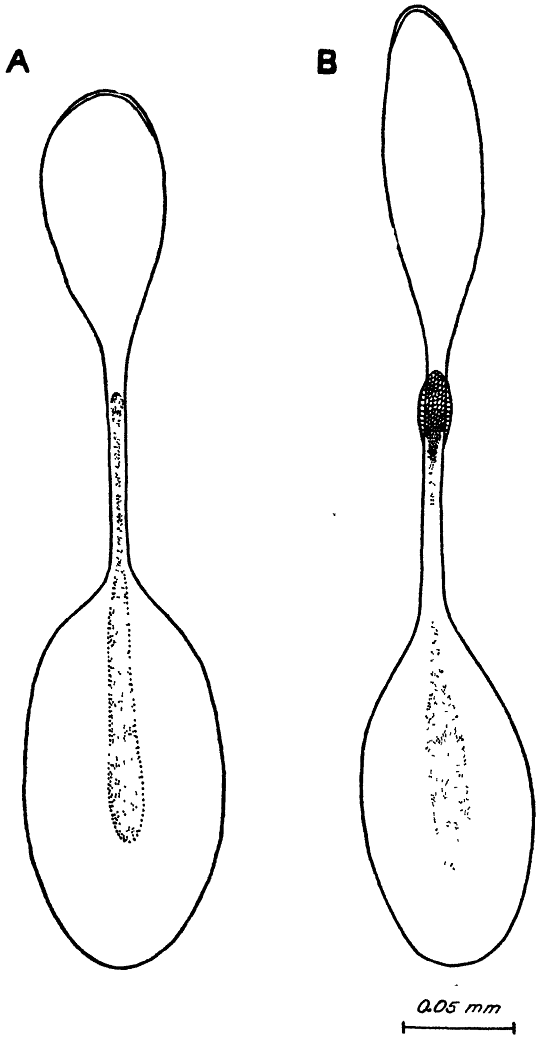

Fig. 66. *A, Metaphycus flammeus* Comp. Ovarian egg. *B, Pseudleptomastix squammulata* Gir., ovarian egg.

Quaylea whittieri (Gir.)

This common, introduced species is hyperparasitic on many of the parasites of scale insects introduced into California. An extensive study was not made.[8]

The undeposited egg (fig. 8, *B*) may be said to resemble that of *Cheiloneurus*. The similar features are simplicity in structure, long neck, and small undifferentiated bulb. The neck is obviously fragile and becomes readily dis-

[8] [The first instar larva of *Quaylea whittieri* is atracheate. It molts while enclosed in its embryonic membrane (trophamnion). S.E.F.]

torted in mounting procedures. In the prepared mounts it is never regular in outline but is partly collapsed. The bulb is slightly wider than the neck, is short, and has a truncated apex. The measurements were: length of bulb, 0.107 mm.; width of bulb, 0.021 mm.; length of neck, approximately 0.47 mm.; length of egg, 0.133 mm.; width of egg, 0.073 mm.

Spaniopterus crucifer Gahan

Taylor (1935) was able to obtain very little information on this scale parasite. Deposited eggs were not found. Ovarian eggs and young larvae were said to be similar to those of *Comperiella unifasciata*. The first instar larvae are probably apneustic or possibly atracheate.

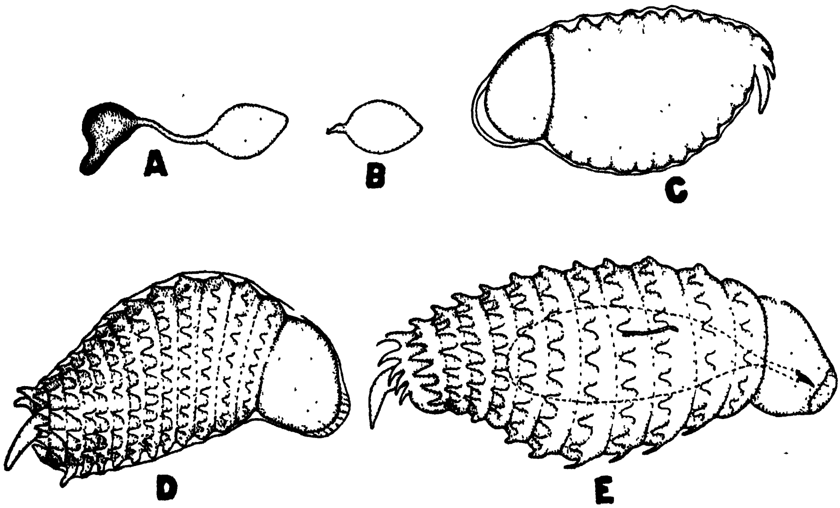

Fig. 67. *Tetracnemus pretiosus* Timb. *A*, ovarian egg; *B*, newly laid egg; *C*, first instar larva on fourth day within chorion; *D*, on fifth day; and *E*, on seventh day. (After Clancy, 1934.)

Stemmatosteres apterus Timb.

This minute wingless species was secured from a single infestation of an unknown species of *Phaenacoccus* near Fillmore, California. Deposited egg and newly hatched larva were not examined.

The ovarian egg (fig. 62, *C*) is similar to those of *Acerophagus* spp., the simplest type of egg. The measurements were: length of bulb and neck, 0.12 mm.; maximum width of bulb, 0.021 mm.; length of egg, 0.09 mm.; maximum width, 0.042 mm.

From the appearance of the ovarian egg it is assumed that the deposited egg lies free within the host and the larva has no spiracles.

Tetracnemus pretiosus Timb.

This primary parasite of mealybugs was discussed by Compere and Smith (1932) and in more detail by Clancy (1934). Only a few points need to be repeated here. Immature stages are shown in figure 67.

The ovarian egg is double-bodied with a smooth surface throughout. The deposited egg lies free in the body fluids of the host and gradually increases in size with the development of the embryo. The first instar larva does not hatch immediately but remains enveloped by the chorion for nearly half of the stadium. During that time it is said to be atracheate. After eclosion the only suggestion of a respiratory system is a tiny pair of tracheal trunks. This condition has been found with only one other encyrtid, *Anarhopus sydncyensis* Timb.

Zarhopalus corvinus (Gir.)

This primary parasite of mealybugs has an unmodified ovarian egg. The bulb is almost spherical in outline. There is no thickening of the apex. The neck is notably short and the structure of the chorion differs in no way from that of the rest of the egg. The main body is as wide as the bulb but one-third again as long. The shape is more or less oval, regardless of aspect. The eggs of a single female differed slightly in size and shape. The average measurements were approximately as follows: length of bulb, 0.15 mm.; width of bulb, 0.1 mm.; length of neck, 0.021 mm.; length of egg, 0.22 mm.; width of egg, 0.098 mm.

All stages were investigated by Clausen (1924). The deposited egg was noted to be free-floating within the body of the mealybug host. The bulb part of the ovarian egg was collapsed after deposition and was occasionally observable as a small irregular protuberance. The larva was of the tailed type, i.e., the last segment was prolonged into an appendage which was bent at an angle of 30 degrees to the axis of the body. The tracheal system appeared to be apneustic.

Miscellaneous

A number of species could not be adequately investigated but sufficient evidence was secured concerning them to indicate the probable type of egg and tracheal system in each. The following species probably have banded eggs and metapneustic larvae:

Chalcaspis phenacocci (Ashm.)
Encyrtus californicus (Gir.)
Habrolepis rouxi Comp.
Leptomastix dactylopii How.
Metaphycus eruptor (How.)
Metaphycus fuscipennis (How.)
Metaphycus lecanii (How.)
Metaphycus similis (Timb.)
Metaphycus spp.
Ooencyrtus sp.

The following species are likely to have unbanded eggs and apneustic larvae:

Bothriencyrtus sp.
Cheiloneurus lineascapus Gahan
Chrysoplatycerus ferrisi Timb.
Chrysoplatycerus splendens How.
Chrysopophagus amplicornis (Gahan)
Cirrhencyrtus ehrhorni (Timb.)
Diversinervus smithi[9] Comp.
Homalotylus spp.

[9] [*Diversinervus smithi* deposits unbanded eggs entirely within the central nerve ganglion of the black scale, *Saissetia oleae*. As many as 25 eggs may be deposited in one host. The first instar larvae is unique in possessing a pair of large, thin-walled cephalic vesicles. It lacks a tail. The first larval molt is inhibited until the host is gravid. S.E.F.]

SUMMARY

The Encyrtidae are a large family of minute parasitic Hymenoptera that most frequently attack such insects as mealybugs and scales. Nearly all the species of this family pass the entire developmental period within the host. The structure and behavior of certain primary larvae of the Encyrtidae are correlated with a respiratory modification of the eggshell, the aeroscopic plate, or band.

Correlating factors are: (1) the presence of air within the aeroscopic plate, (2) the position of the larval spiracles with respect to the aeroscopic plate, (3) the closed lumen of the egg stalk, (4) the course of stained oils in the aeroscopic plate and larval tracheae, and (5) the association between banded and unbanded eggs and open and closed tracheal systems.

The ovarian egg consists of two ovoid bodies connected by a narrow tube. One body serves as a reservoir for the contents of the other as the egg passes down the ovipositor. The entire contents of the egg remain in the posterior body when oviposition is completed.

On the basis of structure the eggs are of three types; unbanded, banded, and intermediate. An unbanded egg has a smooth shell, with no modifications, and is always placed wholly within or without the host. A banded egg has a shell of intricate structure. One side of the connecting neck and an elongate area on the egg proper appear to have a cell-like composition. This band or plate differs among species but is constant within each species. In the process of deposition the banded egg is placed so that the neck projects from the host's body. The band invariably has the appearance of containing air. Intermediate eggs lack very complex shells but possess thickenings or modifications which, in varying degrees, are suggestive of bands. These are also placed so that the neck extends from the body. The morphological differences exhibited by the three types of eggs are of value in generic and specific differentiations.

The larvae of the primary stages may be placed in two categories on the basis of the respiratory structures—those with closed systems of tracheae and those with tracheal systems bearing two, rarely four, caudal spiracles. Larvae that hatch from eggs of the intermediate and unbanded types are apneustic, and usually lie completely free within the hosts. Metapneustic larvae hatch from banded eggs only and remain partly enclosed posteriorly by shell so that the spiracles are in position to gain contact with the air-bearing structures on the egg proper.

Larvae, with or without spiracles, may obtain oxygen from the blood of the host by osmosis. It has heretofore been assumed that those with spiracles utilized atmospheric air passing through the lumen of the neck of their eggshells. Evidence is given which indicates that this is not correct and that the band structures in the wall of the neck provide means whereby atmospheric air is directly conveyed to the larvae. The supply of oxygen obtained by this means is necessary for the complete development of metapneustic larvae.

The respiratory adaptations of sixty-seven species of Encyrtidae are discussed in some detail. Twenty species are mentioned briefly.

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SYSTEMATICS OF THE CALIFORNIA SPECIES OF THE GENUS PEPSIS FABRICIUS

(Hymenoptera: Pompilidae)

BY

PAUL D. HURD, JR.

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SYSTEMATICS OF THE CALIFORNIA SPECIES OF THE GENUS PEPSIS FABRICIUS
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INTRODUCTION

THE PRIMARY objectives of this paper are to attempt to standardize the nomenclature of the species concerned, present the known distribution, and provide a working basis for biogeographical studies of the genus *Pepsis* within California. A comprehensive study of this sort has long been needed, for much confusion has existed with regard to the western species, particularly those of California, since the appearance of the monograph on the genus by Lucas (1895). This condition has arisen, at least in part, because later students of the group have had to work with relatively few specimens from a large geographical area.

The writer has been fortunate in obtaining a large number of western specimens, particularly from California. Notwithstanding, the distribution of the genus in the State is far from being understood, since it is now apparent that it is determined by a complex of biological and ecological factors.

The species of *Pepsis* have been observed to visit various flowering plants, usually those characteristic of the chaparral. They are most commonly found on milkweed (*Asclepias*) and undoubtedly are one of the most important pollinators of that genus. It is interesting to note that in most of the localities from which *Pepsis* specimens have been taken, or examined, either *Asclepias* is present with the wasps upon it, or the pollinia have been observed clinging to the tarsi. In fact, it has been possible to predict, with some degree of certainty, the localities where *Pepsis* are to be found by examination of the distribution of *Asclepias.*

Other flowering plants visited by these wasps include: *Acacia greggii, Baccharis glutinosa, Cotoneaster* spp., *Eriogonum fasciculatum, Lepidospartum squamatum, Medicago sativa, Melilotus alba, Mentha citrata, Photinia arbutifolia, Platystemon californicus, Prosopis juliflora, P. pubescens, Rhus laurina,* and *Schinus molle.*

Pepsis appears to be limited in distribution to the foothill areas and is in general absent from the larger valleys such as the Sacramento, the San Joaquin, and the Imperial. Occasional specimens may be found in these valley areas, but probably not in significant numbers. One important limiting factor is the distribution of the hosts, arachnids of the family Theraphosidae (= Aviculariidae), which are presumed to be the prey of the female. This seems to be borne out by a cursory examination of the distribution of these spiders. The northern distributional barrier is apparently one of temperature, since other

bioecological factors beyond this northern periphery appear to be the same as those found in the distributional pattern of the genus. However, much data will be necessary before we shall be able to enumerate with a fair degree of certainty the controlling distributional factors.

Of the eight species (one new) now known to occur in California only three (*thisbe, mildei,* and *chrysothemis*) are of common and widespread occurrence; three (*elegans, pattoni* and *sherillae*) are rare, being known from but a few specimens; one (*pallidolimbata*) is of infrequent occurrence; and one (*mexicana*) is locally common in the southern part of the State. Many areas remain to be sampled, in particular the four southeastern counties. It appears likely that species expected to occur within the State will be collected in that area.

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The following key is based, necessarily, upon characteristic specimens of the species. Many critical characters are lost in older or damaged specimens, this being particularly true of the female. Uncertainties concerning the correct placement of the male may be clarified by dissection of the genitalia and examination of the subgenital plate.

KEY TO THE CALIFORNIA SPECIES OF PEPSIS

1. Males (antennae not convolute, thirteen-segmented except in *pattoni,* where twelve-segmented; abdomen with seven visible tergites)[1] 2
   Females (antennae convolute, twelve-segmented; abdomen with six visible tergites). 10
2. (1) Wings faintly infuscated with varying shades of brown or black, clothed with yellow, orange, red, or rust brown (or combinations thereof) tomentose hairs. 3
   Wings heavily infuscated with dark brown, clothed with green, blue, purple (or combinations thereof) tomentose hairs, or simply violaceous.............. 7

[1] The terminology employed here is that in general usage by systematists, although morphologically the first segment is actually the second since the first is intimately fused with the thorax.

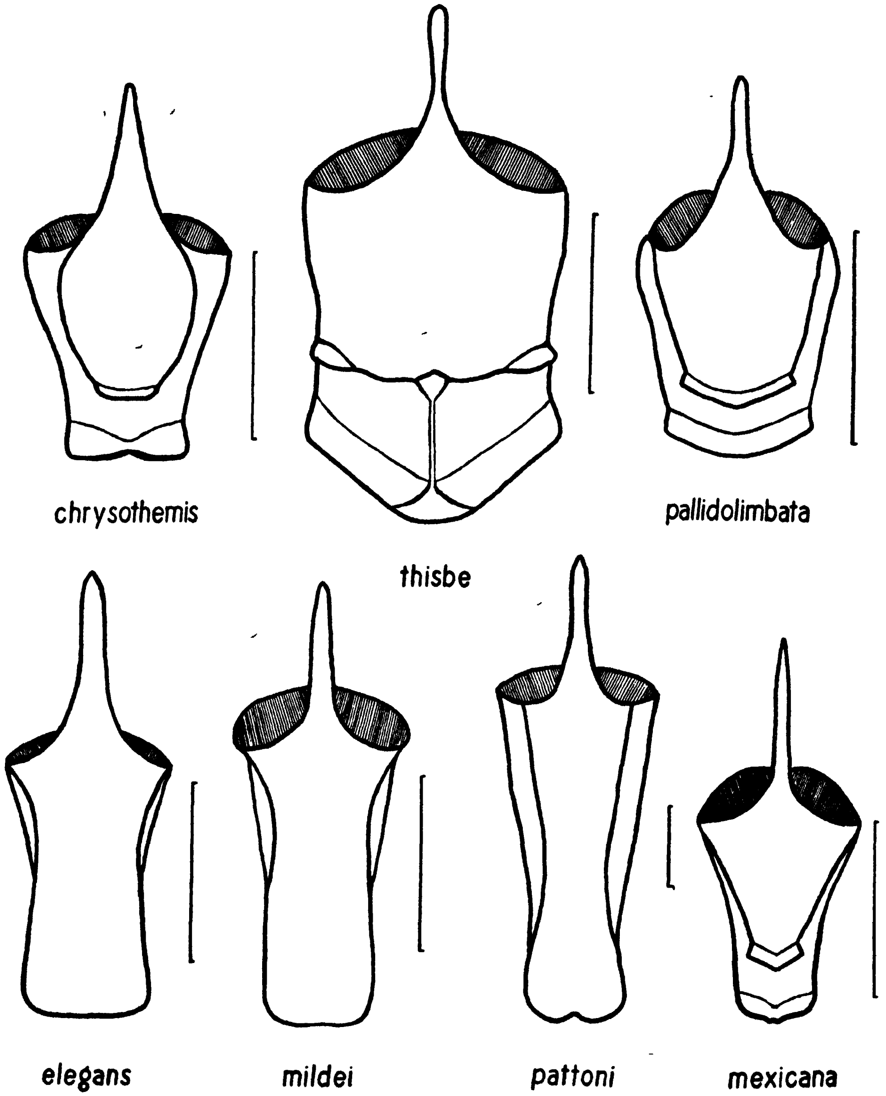

Fig. 1. Male subgenital plates of the California species of the genus *Pepsis*. Delineated lines indicate one millimeter.

3. (2) Antennae wholly black; no "hair brushes" on fourth abdominal sternite; subgenital plate[2] with transverse carinae, or with apical transverse carina and subapical median tooth; forewings without distinct exterior marginal dark band 4

Antennae with at least apical segment orange or reddish orange (usually apical three-fourths of antennae orange or reddish orange); fourth abdominal sternite with two oblique rows of bristles forming "hair brushes"; subgenital plate without transverse carinae or median tooth; forewings with broad exterior marginal dark band .... *mildei*

[2] Unless otherwise specified, the term subgenital plate refers to that part of the plate which is visible without dissection of the genitalia.

4\. (3) Subgenital plate with apical and subapical transverse carinae, no subapical median tooth 5
Subgenital plate with apical transverse carina and low transverse carina which extends laterad on either side of blunt, subapical median tooth .... *thisbe*

5\. (4) Subgenital plate with subapical carina extending nearly to lateral edges, not strongly arcuate; exterior submarginal dark band of forewing, if present, less than width of antennal scape 6
Subgenital plate with subapical carina much less than width of subgenital plate, strongly arcuate; exterior submarginal dark band of forewing broad, greater than length of antennal scape .... *chrysothemis*

6\. (5) Wings yellowish brown; iridescent tomentum of head, body, and legs with greenish sheen .... *pallidolimbata pallidolimbata*
Wings reddish brown; iridescent tomentum of head, body, and legs with dark blue-green sheen. (Known only from the Mount Hamilton range of California) *pallidolimbata smithi*

7\. (2) Antennae black; no "hair brushes" on fourth abdominal sternite; forewings with an exterior marginal, whitish hyaline band 8
Antennae with at least apical three-fourths orange or reddish orange; fourth abdominal sternite with two oblique rows of bristles forming "hair brushes"; forewings without an exterior marginal, whitish hyaline band .... *elegans*

8\. (7) Subgenital plate not elongate, not long-haired, with apical and subapical transverse carinae, or with apical transverse carina and subapical median tooth... 9
Subgenital plate elongate, long-haired, no transverse carinae or subapical median tooth .... *pattoni*

9\. (8) Subgenital plate attenuated posteriorly, bearing an apical and subapical transverse carina .... *mexicana*
Subgenital plate nearly rectangular, bearing an apical transverse carina and a subapical median tooth .... *sherillae*

10\. (2) Wings faintly infuscated with varying shades of brown and black, clothed with yellow, orange, red, or rust brown (or combinations thereof) tomentose hairs. 11
Wings heavily infuscated with dark brown, clothed with green, blue, purple (or combinations thereof) tomentose hairs, or simply violaceous 15

11\. (10) Forewings with a dark exterior marginal or exterior submarginal band 12
Forewings without a distinct dark exterior marginal or exterior submarginal band 14

12\. (11) Antennae black; exterior marginal, submarginal, and humeral bands *not* reflecting copper hues viewed in bright light 13
Antennae with at least apical segment orange or reddish orange (usually apical three-fourths of antennae orange or reddish orange), exterior marginal and humeral bands reflecting copper hues when viewed in bright light .... *mildei*

13\. (12) Wings fiery red; forewings with a rather broad, dark, exterior marginal band; pronotum densely clothed with erect, black hairs which are best seen when the pronotum is viewed laterally .... *chrysothemis*
Wings reddish brown (though in some nearly as red as in *chrysothemis*); forewings with a dark, exterior submarginal band that pales marginally to almost whitish hyaline; pronotum glabrous or nearly so .... *thisbe*

14\. (11) Wings pale yellow .... *pallidolimbata pallidolimbata*
Wings reddish brown (known only from the Mount Hamilton range of California) *pallidolimbata smithi*

15\. (10) Antennae black; forewings with exterior marginal band whitish hyaline 16
Antennae with at least apical three-fourths orange or reddish orange; forewings without whitish hyaline exterior marginal band .... *elegans*

16\. (15) Hind wings with whitish hyaline apices; front femora glabrous beneath .. *mexicana*
Hind wings without whitish hyaline apices; front femora clothed with long hairs beneath .... *pattoni*

Pepsis mildei Stål

Pepsis mildei Stål, 1857, Öfvers. af K. Vet.-Akad. Förh., 14 (2):64; Lucas, 1895, Berlin. entom. Zeitschr., 39:754, 769, 777–778; Dalla Torre, 1897, Cat. Hymen., 8:257; Fox, 1898, Proc. Ent. Soc. Wash., 4:141, 142, 145; Brèthes, 1914, Anal. Mus. Nac. Hist. Nat., Buenos Aires, 26:260; Lucas, 1917, Arch. Natg., 83 (5):126, 130, plate 1, figure 26; Banks, 1919, Bull. Mus. Comp. Zool., Harvard College, 63:248; Banks, 1921, Ann. Ent. Soc. Amer., 14:22; Passmore, 1933, Nat. Geog. Mag., 64: 205, photograph p. 203; Clark, 1937, Nat. Geog. Mag., 72:50, 55.

Pepsis hesperiae Patton, 1894, Proc. Ent. Soc. Wash., 3:46–47; Fox, 1894, Proc. Cal. Acad. Sci., 4 (2):101.

**Pepsis boguei* Fox, 1898, Proc. Ent. Soc. Wash., 4:141, 142, 146–148; Brèthes, 1914, Anal. Mus. Nac. Hist. Nat., Buenos Aires, 26:261, 262; Lucas, 1917, Arch. Natg., 83 (5):154; Banks, 1921, Ann. Ent. Soc. Amer., 14:23. (New synonymy.)

Diagnostic characters. Male.—Length 18 to 32 mm. Wings yellowish brown with distinct humeral and exterior marginal dark band on forewing, and distinct dark band on hind wing extending marginally from apex posteriorly to and continuous with broad, humeral, dark band; antennae with apical three-fourth orange or reddish orange;[3] head, thorax, abdomen, and legs black, clothed with fine tomentum reflecting blue-green or purplish iridescence; fourth abdominal sternite with two oblique rows of bristles forming "hair brushes"; subgenital plate nearly rectangular, black, clothed rather densely with short, black hairs. *Female.* Length 28 to 42 mm. Similar to the male in coloration and vestiture, but lacking the ventral "hair brushes."

Male.—Head black, clothed with rather short, erect, brownish black hairs and finely appressed iridescent tomentum which reflects blue-green or purple; ocelli slightly elevated, hind ocelli bounded laterally by a small, ill-defined depression; a weak impressed line runs from anterior ocellus to antennal sockets; antennal scape and pedicel black, clothed with iridescent tomentum and very short, brownish black hairs; flagellum glabrous, bright orange except basal segment, which is proximally black (see footnote 3); clypeus black, subrectangular, swollen medially, lateral margins strongly convergent toward apex, minutely punctate, apical margin broadly concave though somewhat angled medially; entire surface clothed with iridescent tomentum and a few short black hairs; mandibles dark brown, almost black, irregularly punctate, clothed exteriorly with a few long, brown hairs. *Pronotum* nearly vertical, shoulders prominent, integument black, clothed with numerous short, black hairs and iridescent blue-green or purplish tomentum. *Propodeum* strongly wrinkled transversely, horizontal surface raised medially and bearing a well-defined but shallow mediolongitudinal furrow which abuts posteriorly against a short but prominent transverse carina; lateral carinae developed as rounded ridges which terminate posteriorly as distinct, somewhat dentate processes; sloping surface bears a low transverse carina which extends to bases of lateral teeth; remainder of sloping surface irregularly wrinkled; entire surface of propodeum clothed with rather long, brownish hairs, and blue-green or purplish tomentum. *Wings* yellowish brown, covered with short, fine, brownish hairs; veins dark reddish brown; exterior marginal and humeral bands dark brown, reflecting copper in bright light; humeral band nearly twice the greatest width of exterior marginal band; exterior marginal band of forewing extending from the serial vein and apex to axillary excision, but narrowing posteriorly, darkest near its inner margin; humeral band extending nearly one-half length of median cell; exterior marginal band of hind wing somewhat narrower than exterior marginal band of forewing, but broadening posteriorly and merging with humeral band which extends at least into one-third of the median cell. *Legs* similarly clothed as

[3] In some specimens, both male and female, the orange or reddish orange color is limited to the apical segments or segment, being replaced in part or in full, on the basal segments, with black. There seems to be a continuous variation in this respect, particularly with specimens from the interior. Coastal specimens, and some from the interior, however, are as decribed. In some Arizona material the antennae are entirely black, but the writer does not, at this time, consider this fact significant enough to warrant varietal status.

integument, coxae clothed ventrally with short, dark brown hairs; inner hind tibial spur about one-third length of basitarsus; claws dark brown, armed basally with a short, distinct tooth. *Abdomen* subpetiolate; when viewed from above, elongately ovate, flattened somewhat ventrally; entire surface clothed with blue-green or purplish tomentum; first sternite bears a few, short, brownish hairs; fourth sternite with two oblique rows of long, black,

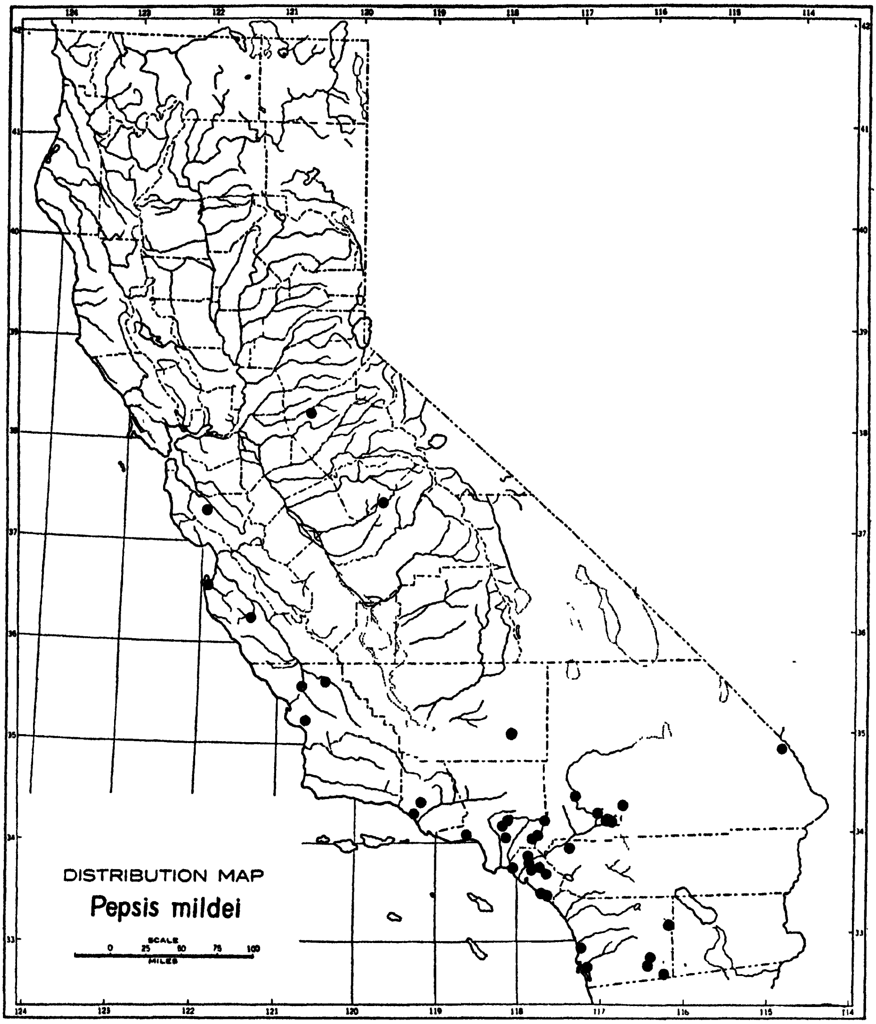

Fig. 2. Distribution of *Pepsis mildei.*

apically curved bristles; fifth sternite bears posteriorly two short tufts of black bristles; apical tergites clothed irregularly with rather short, brownish hairs. *Subgenital* plate elongate, posterior edge nearly truncate, slightly turned downward; ventral surface clothed with numerous short, black hairs.

Female.—Similar to male in coloration and vestiture, but more robust; ventral surface of abdomen devoid of "hair brushes," tibial and tarsal spines stouter and better developed; exterior marginal and humeral wing bands may be somewhat more restricted in extent.

Type locality.—"California," for *mildei;* "Poway, San Diego Co., Calif.," for *hesperiae;* "Texas," for *boguei.*

Recorded host.—Bothriocyrtum californicum Cambridge. (Passmore, 1933.)

Recorded California distribution.—"Californien" (Lucas, 1895); "California" (Dalla Torre, 1897). SAN DIEGO CO.: San Diego (Lucas, 1895); Poway (Patton, 1894). LOS ANGELES CO.: Claremont (Banks, 1919); Pasadena (Banks, 1919). SAN LUIS OBISPO CO.: San Luis Obispo (Banks, 1919). SANTA CLARA CO.: San Jose (Banks, 1919).

New California records.—SAN DIEGO CO.: San Diego, 2 ♀♀, IX-16-23 (F. E. Blaisdell); 1 ♀, VII-4-31; 1 ♂, VIII-30-27; 1 ♀, VI-27-20 (W. S. Wright); 1 ♀, VII-17-20 (W. S. Wright); 1 ♀, IX-12-21; 1 ♀, VII-25-28 (C. Searl); 1 ♀, X-20-20 (G. H. Fields). Jacumba, 1 ♂ (J. Bequaert). San Felipe Valley, 3 ♂♂, VII-24 to 28-20. Pine Valley, 9 ♂♂, VIII-6 to 21-27; 2 ♂♂, IX-12-27 (F. W. Kelsey). Morena, 2 ♂♂, VIII-4-28 (C. Searl). Del Mar, 1 ♀, VIII-5-26 (V. M. Chase). ORANGE CO.: Brea, 2 ♂♂, VIII-25-33 (A. J. Basinger). Laguna Beach, 4 ♂♂, VIII-7-36 (P. H. Timberlake); 2 ♂♂, VIII-1-28 (E. M. Furlong; 1 ♀, (W. M. Wheeler). Arch Beach, 2 ♂♂, 1 ♀, VII-2-25 (L. J. Muchmore). Orange, 3 ♂♂, VIII-20-39 (T. C. Russell). Mt. Santiago, 1 ♂, IX-9-36 (P. H. Timberlake). Orange County Park, 1 ♂, IX-9-13 (B. L. Boyden). Santa Ana Mountains, 1 ♂, IX-1933 (E. E. Seibert). RIVERSIDE CO.: Riverside, 2 ♀♀, X-4-36 (P. H. Timberlake). SAN BERNARDINO CO.: Oak Glenn Lodge, 5000 ft., 2 ♂♂ (F. S. Daggett). Mill Creek Canyon, 1 ♂, IX-13-22 (E. P. Van Duzee). Rattlesnake Bridge, 1 ♂, VIII-29-27 (C. C. Wilson). Victorville, 1 ♂, VIII-11-87 (W. S. Wright). Old Woman Springs, 1 ♀, X-22-27 (P. H. Timberlake). Mojave, 1 ♀, VIII-1-? (W. J. Chamberlain). Needles, 1 ♀, VIII-1-? (W. J. Chamberlain). LOS ANGELES CO.: Camp Baldy, 2 ♂♂, 1 ♀, VIII-24-20 (P. H. Timberlake); 1 ♂, 1 ♀, VIII-18-29 (P. H. Timberlake). Pomona Mountains, 1 ♀ (H. C. Fall). Mt. Wilson, 2400 ft., 1 ♂ (J. Bequaert). Voltaire, 1 ♀, IX-5-22 (J. D. Gunder). Long Beach, 1 ♀ (F. S. Daggett). Whittier, 1 ♀ (L. L. Muchmore). Pomona, 1 ♂, VI-15-34 (B. J. Hall). VENTURA CO.: Ventura, 1 ♀, IX-15-23 (A. G. Stall). Santa Paula, 1 ♀ (E. O. Essig). SAN LUIS OBISPO CO.: Paso Robles, 1 ♂, IX-8-28 (L. S. Slevin). Pozo, 1 ♂, VII-1925 (C. Sharp). MONTEREY CO.: Carmel, 1 ♀, IX-26-34 (L. S. Slevin). Paraiso Springs, 1 ♀, VIII-29-24 (L. S. Slevin); 1 ♂, VIII-28-24 (L. S. Slevin). SANTA CLARA CO.: San Jose, 1 ♂ (F. Patterson). ALAMEDA CO.: Corral Hollow, 6 ♂♂, 1 ♀, X-5-42 (R. F. Smith); 1 ♂, IX-10-46 (P. D. Hurd, Jr., and R. F. Smith). CALAVERAS CO.: Mokelumne Hill, 3 ♂♂, August (F. E. Blaisdell). MADERA CO.: Ahwanhee, 1 ♀ (A. P. Morse).

Flight period.—♂♂ 15 June to 13 September. ♀♀ 24 June to 22 October.

This species is distinguishable at once from all our known California species by the orange antennae and yellowish brown, dark, exterior marginally banded wings. The most closely related species structurally appears to be *elegans* Lepeletier, from which it differs principally by not having the dark brown, violaceous wings.

P. boguei Fox belongs here, but may, when material enough is available, constitute a variety of this species. As already noted in the redescription of *mildei*, the more interior specimens show a remarkable lessening, or complete obliteration, of the orange color of the antennae. Thus far, no specimen examined by the author which has been taken from a locality west of the Coast Ranges exhibits this variation. In desert specimens this condition is even more pronounced.

Pepsis thisbe Lucas

Pepsis formosa, Cresson, 1867, Trans. Amer. Ent. Soc., 1:144 (in part, *nec* Say, 1823, *et al.*); LeConte, 1883, Writ. of Th. Say, 1:92 (*nec* Say, LeConte's note); Rohwer, 1917, Proc. U. S. Nat. Mus., 53:239; Banks, 1919, Bull. Mus. Comp. Zool., Harvard College, 63:248; Banks, 1921, Ann. Ent. Soc. Amer., 14:23. (All new synonymy.)

Pepsis thisbe Lucas, 1895, Berlin. entom. Zeitschr., 39:732, 733, 737, 744-745, plate 26, figure 44, plate 33, figure 195; Brèthes, 1914, Anal. Mus. Nac. Hist. Nat., Buenos Aires, 26:258, 259; Lucas, 1917, Arch. Natg., 83 (5):108, 110, 111.

Pepsis sayi Banks, 1926, Can. Ent., 58:202–203. (New synonymy.)

Diagnostic characters.—Male. Length 18 to 30 mm. Wings dark reddish brown (though sometimes appearing reddish) with a distinct blackish brown humeral band and brownish exterior submarginal band on forewing; a distinct exterior submarginal brown band on hind wing which becomes marginal posteriorly before joining blackish brown humeral band; apices and exterior marginal areas delimited by infuscated whitish hyaline border which narrows posteriorly. Antennae black. Head, thorax, abdomen, and legs black, clothed with finely appressed tomentum reflecting blue-green or purplish iridescence. Subgenital plate short, scarcely longer than wide, black or brownish black, clothed with rather fine, short, brown or brownish black pubescence; lateral margins convergently arcuate, apical margin somewhat carinate, obtusely angled, slightly rounded off; a subapical carina extends laterad on either side of blunt, subapical, median tooth nearly to lateral margins of plate. *Female.* Length 32 to 44 mm. Similar to male, but more robust. Apices and exterior marginal wing areas even more infuscated, not clearly whitish hyaline; exterior submarginal and humeral bands less intense in coloration. Pronotum devoid of hairs or very nearly so.

Male.—Head black, clothed with numerous, erect, short to long, black hairs (those between antennal bases sometimes compressed into short hair tufts) and closely appressed blue-green or purplish iridescent tomentum; ocelli somewhat elevated, hind ocelli bounded laterally by shallow depression; a narrow but well-developed groove runs posteriorly from antennal bases to or near anterior ocellus; antennal scape black, clothed with finely appressed blue-green tomentum and a few, very short, black hairs; pedicel and flagellum black, glabrous; clypeus black, swollen medially, apical margin angulately emarginate, clothed with finely appressed blue-green iridescent tomentum and short, black hairs; mandibles black (variable), clothed exteriorly with a few, long, black hairs. *Pronotum* vertically produced, shoulders poorly developed; entire surface clothed with numerous black hairs and blue-green (or purplish) tomentum. *Propodeum* subcuboidal, wrinkled transversely, clothed with rather long, fine, dark brown hairs; horizontal surface convexly produced, medially bearing a shallow longitudinal furrow which is traversed by carinate wrinkles; lateral carinae obsolete, replaced by rounded, short, transverse carinate ridges which terminate posteriorly as small humps; horizontal surface separated by transverse carina, best developed medially, disappearing laterally; sloping surface transversely wrinkled. *Wings* dark reddish brown, covered with short, golden, orange, reddish brown, or blackish tomentose hairs (the color of the wings is dependent, at least in part, upon combinations of the above hairs and hence in older or damaged specimens the wings may be completely devoid of the characteristic coloration); veins dark reddish brown; humeral band blackish brown, narrow, usually one-fourth length of median cell or may be absent; apices and exterior marginal band of forewing whitish hyaline (though in many infuscated), narrowing posteriorly, disappearing near inner angle; exterior submarginal dark band broad, about one-half width of apical field, extending posteriorly adjacent to closed cell veins from anterior wing edge into cell *3 Cu;* whitish hyaline character of exterior marginal border of hind wing less distinct, narrower; exterior submarginal dark band of hind wing less intense, begins at radial vein, progresses posteriorly and marginally, ultimately broadening and joining humeral band. *Legs* similarly clothed as integument, devoid of hairs except on coxae where clothed with rather long, fine, black hairs; inner hind tibial spur nearly one-half length of basitarsus; claws black, or dark brown, armed basally with well-developed tooth. *Abdomen* is elongately ovate, clothed with finely appressed blue-green (or purplish), iridescent tomentum; sternites and terminal tergites bear a few, short, black hairs. *Subgenital plate* convex, short, scarcely longer than wide, black or brownish black, clothed with rather fine, short, brown or brownish black pubescence except area between apical and subapical transverse carinae which is sparsely, if at all, clothed; lateral margins convergently arcuate; apical margin abruptly curved downward, carinate, obtusely angled, sometimes slightly rounded off, clothed densely on posterior surface with fine, erect, short, brownish pubescence; a subapical carina extends laterad on either side of a distinct but blunt subapical median tooth (this carina is bent posteriorly about midway on either side of the blunt tooth, but again turns anteriorly ending abruptly near the lateral margin of the plate; in some specimens

the lateral median portion of the carina is missing); area delimited by apical and subapical transverse carinae is hollowed out and shiny.

Female.—Similar to male, but more robust. Antennal flagellum characteristically black, though in some specimens it is lighter below and at apices of joints. Wing apex and exterior marginal band infuscated, not distinctly whitish hyaline; dark exterior submarginal band

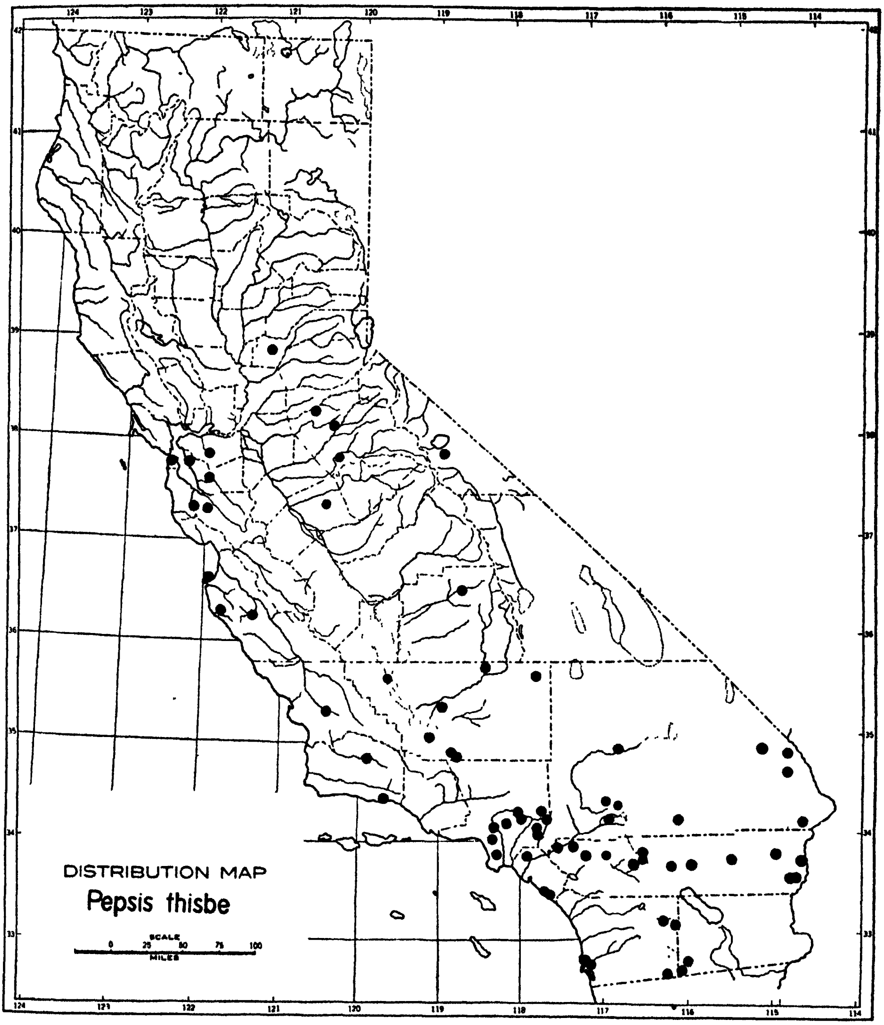

Fig. 3. Distribution of *Pepsis thisbe.*

narrower, more diffusely colored. Propodeum similar to that of male, but lateral teeth developed as carinate processes. Pronotum devoid of hairs or very nearly so.

Type locality.—"Cuernavaca, Mexiko," for *thisbe;* "Palmerlee, Arizona," for *sayi.*

Recorded California distribution.—"California" (as *formosa,* in part, Cresson, 1867). San Diego Co.: San Diego (as *formosa,* in part, LeConte, 1883). Calaveras Co.: (as *formosa,* Rohwer, 1917). Kern Co.: San Emigdio (as *formosa,* Banks, 1919). San Bernardino Co.: Twentynine Palms (as *chrysothemis,* McKenzie, 1933).[4]

[4] Through the courtesy of Mr. P. H. Timberlake the writer has examined some of the specimens upon which this report was based.

New California records.—IMPERIAL Co.: Mountain Spring, 3 ♂♂, VII-6 to 7-20. Painted Gorge, 1 ♀, V-12-34 (I. Moore). SAN DIEGO Co.: San Diego, 2 ♂♂, 1 ♀, VII-23-25 (P. H. Timberlake); 1 ♀, VIII-14-28 (C. Searl); 1 ♀, VIII-6 to 9-44; 1 ♀, VI-29-23; 1 ♀, VIII-12-27 (R. Wilson); 5 ♂♂, VII-17-20 (W. S. Wright). San Felipe Creek, 1 ♀, IX-15-35 (F. T. Thorne). San Felipe Valley, 1 ♂, 2 ♀♀, VI-24 to 28-20; 1 ♀, V-20-25 (C. Searl); 2 ♂♂, VI-6-40 (H. T. Reynolds); 1 ♀, VI-7-40 (C. D. Michener). Jacumba, 1 ♀, VI-25-40 (K. S. Hagen). Ocean Beach, 1 ♀, VIII-24-28 (C. Searl). ORANGE Co.: Arch Beach, 4 ♂♂, VII-2-25 (L. J. Muchmore). Fullerton, 1 ♂, 1 ♀, VIII-7-39 (T. C. Russell); 1 ♀, VIII-11-39 (T. C. Russell). Laguna Beach, 1 ♀, VIII-7-36 (P. H. Timberlake). RIVERSIDE Co.: Riverside, 1 ♀, VII-1924 (H. Compere); 1 ♀, VI-4-25 (P. H. Timberlake); 1 ♂, VIII-11-27 (P. H. Timberlake); 1 ♂, VIII-10-36 (W. Reeves). Corona, 1 ♀, VII-8-09. Palm Springs, 1 ♂, V-23-17 (E. P. Van Duzee); 1 ♂, IV-3-25 (E. C. Van Dyke); 1 ♀, V-21-17 (E. P. Van Duzee). Coachella, 1 ♂, V-16-17 (E. P. Van Duzee). Desert Center, 1 ♀, V-22-39 (E. P. Van Duzee). Piñon Flat, San Jacinto Mts., 1 ♀ (D. J. Knull). Gilman Hot Springs, 1 ♂, VII-6-20. Blythe, 1 ♂, VII-10-46 (W. F. Barr). 17 miles north of Blythe, 1 ♂, VI-12-40 (K. S. Hagen); 1 ♀, VIII-27-46 (W. F. Barr and P. D. Hurd, Jr.). 20 miles west of Blythe, 14 ♂♂, 16 ♀♀, VI-17-46 (W. F. Barr, E. G. Linsley, J. W. MacSwain, and R. F. Smith); 7 ♀♀, VII-20-46 (P. D. Hurd, Jr., and R. F. Smith). 25 miles west of Blythe, 2 ♂♂, VI-1937 (J. C. Elmore). 22 miles north of Blythe, 3 ♂♂, 3 ♀♀, VIII-10-46 (W. F. Barr and P. D. Hurd, Jr.). 5 miles south of Midland, 3 ♀♀, VII-6-46 (W. F. Barr). Mountain Center, 1 ♀, VII-20-46 (P. D. Hurd, Jr., and R. F. Smith). 27 miles east of Indio, 1 ♂, VI-17-46 (W. F. Barr). Box Canyon, 1 ♂, IV-13-34 (P. H. Timberlake). SAN BERNARDINO Co.: Cushenbury Springs, 2 ♂♂, VIII-16-37 (P. H. Timberlake). 8 miles west of Needles, 3 ♂♂, VI-4-38 (P. H. Timberlake). Oak Glenn Lodge, 5000 ft., 3 ♂♂ (F. S. Daggett). Yermo, 1 ♂, VI-9-40 (K. S. Hagen); 3 ♂♂, VI-18-39 (W. M. Pearce). Twentynine Palms, 2 ♀♀, VIII-3-33 (P. H. Timberlake). 10 miles south of Needles, 1 ♀, VIII-25-46 (W. F. Barr and P. D. Hurd, Jr.). 22 miles south of Needles, 1 ♀, VIII-25-46 (W. F. Barr and P. D. Hurd, Jr.). 3 miles south of Vidal, 1 ♀, VIII-10-46 (W. F. Barr). 9 miles east of Goffs, 4 ♂♂, 2 ♀♀, VI-22-31 (H. A. Scullen). LOS ANGELES Co.: Los Angeles, 1 ♀, VI-15-27 (J. A. Hornung). Pasadena, 1 ♂ (F. Grinnell); 2 ♀♀, 1913. Camp Baldy, 1 ♂, 3 ♀♀, VIII-24-20 (P. H. Timberlake); 2 ♀♀, VIII-18-20 (P. H. Timberlake). Pomona, 1 ♀, VIII-4-34 (B. J. Hall); 1 ♂, VI-15-35 (B. J. Hall). Mountains near Claremont, 1 ♀ (Baker). Dalton Canyon, 1 ♀, IX-1933 (E. E. Seibert). Claremont, 1 ♀, VI-4-96. Glendora, 1 ♀, IX-1933 (E. E. Seibert). Compton, 2 ♀♀, 1942 (W. Kahle). Johnstone Mountain, 1 ♀, VIII-25-41 (W. M. St. John). Glendale, 1 ♀ (E. D. Jones). SANTA BARBARA Co.: Sunset Valley, 1 ♂, 1 ♀, VII-4-39 (K. S. Hagen); 1 ♀, VI-28-40 (W. F. Barr). Santa Barbara, 1 ♂ (J. S. Hine). SAN LUIS OBISPO Co.: Pozo, 3 ♂♂, 8 ♀♀, VII-1925 (C. Sharp). KERN Co.: Kernville, 1 ♀ (H. C. Fall). Bakersfield, 2 ♀♀, VIII-1938 (R. F. Smith). Ridge Route near Lebec, 1 ♀, VI-12-40 (D. Wassem). Lost Hills, 1 ♀, VIII-12-13. Inyokern, 1 ♂, VII-18-30 (W. E. Ball). Tejon, 1 ♀, VII-1931 (E. S. Ross). MONTEREY Co.: Paraiso Hot Springs, 2 ♂♂, 1 ♀, VI-18-30 (J. R Slevin); 1 ♀, VI-15-34 (L. S. Slevin). SANTA CLARA Co.: San Jose, 2 ♀♀, VII-4-40 (J. Madsen); Searsville Lake, 1 ♀, IX-19-38 (C. Road). ALAMEDA Co.: Berkeley, 1 ♂, VI-8-46 (W. R Cobb). Kilkare Woods, 1 ♀, VII-13-37 (K. S. Hagen). Corral Hollow, 40 ♂♂, 12 ♀♀, VII-16-46 (P. D. Hurd, Jr., and R. F. Smith). SAN FRANCISCO Co.: San Francisco, 1 ♀, VI-1934. CONTRA COSTA Co.: Mt. Diablo, 1 ♀, VI-13-31 (A. T. McClay); 2 ♀♀, VI-25-41 (C. H. Anderson). PLACER Co.: Lincoln, 1 ♂, July (F. E. Blaisdell). CALAVERAS Co.: Murphys, 2 ♀♀, VII-22-30 (J. F. Lamiman); 1 ♀, VII-20-30 (J. F. Lamiman). Mokelumne Hill, 3 ♂♂, 1 ♀, August (F. E. Blaisdell). MONO Co.: June Lake, 2 ♂♂, VII-1931 (E. E. Seibert). TUOLUMNE Co.: Sequoia, 1 ♀, VII-19-40 (F. H. Wylie). SAN JOAQUIN Co.: Tracy, 2 ♀♀, VII-26-46 (H. T. Reynolds). STANISLAUS Co.: 1 ♂, VIII-9-? (J. G. Grundel); La Grange, 2 ♂♂, 3 ♀♀, VII-1936 (J. D. Vertrees). MERCED Co.: Merced, 3 ♀♀, VII-9-30. TULARE Co.: Sequoia National Park, 2000 to 3000 ft., 2 ♂♂, V-8-31; 3 ♂♂, V-9-31; 2 ♀♀, V-14-31; 1 ♀, V-16-31 (all preceding collected by E. C. Van Dyke).

Flight period.—♂♂ 3 April to 24 August. ♀♀ 12 May to 19 September.

The name *Pepsis formosa* (Say) has erroneously been applied to our California species, *Pepsis thisbe* Lucas, which it quite closely resembles. This confusion arose, at least in part, from the inadequate original description of *formosa* by Say (1823:76). Indeed, at least two species of *Pepsis* fit this description, both of which occur "within a hundred miles of the Rocky Mountains, on the banks of the Arkansaw river." Cresson (1867:144) briefly recharacterized *formosa* from specimens included in the collection of the American Entomological Society and extended the range to California, but apparently failed to observe the critical characters by which our California species differ from that of *formosa.* LeConte (1883:92) remarked that the range of *formosa* extended as far west as San Diego, California, but upon what basis he extended the range is not certain. Cockerell (1898:146) considered the *formosa* interpretation by Lucas (1895:736–738) invalid since it "is apparently not known from the region whence came Say's type, being more southern in its distribution." The name *pseudoformosa* was proposed for the *formosa* of Lucas. Rohwer (1917:329) records two specimens of each sex—*formosa* (Say), 1823—from Calaveras County. This record is undoubtedly referable to *thisbe* Lucas since the author has examined similar material collected in that county by F. E. Blaisdell. Banks (1919:248) reports *formosa* (Say), 1823, from San Emigdio Canyon, Kern County, and separates the species from two other species on the basis of color characters. In 1921 Banks provided a key for the species of *Pepsis* known to him from the United States. Here he characterized the subgenital plate of the male in a manner which is at variance with the monographic redescription of *formosa* by Lucas (*op. cit.*) and the characterization of the subgenital plate of *formosa* as given by Fox (1898:141–142).

The problem of the correct placement of the *formosa* of Say involves the analysis of a complex of species, namely, the true *formosa* of Say, the type of which has been destroyed; the *formosa* of Say as interpreted by Lucas; the *thisbe* of Lucas; and the *nephele* of Lucas. The picture is further complicated since all these species are known to occur within the area of the type locality of the *formosa* of Say ("Inhabits Arkansas").

If for the present we disregard all the species concerned except the true *formosa* of Say, the specific allocation of this species must rest upon the original description and figure supplied by Say. Inasmuch as the description is quite brief and based apparently on the female (as attested by the statement in the description concerning the length of the female body and by the sex of the figured specimen), but little direct information is available. In fact, the only character of value that can be employed to determine which species Say described is the colorational wing pattern of which the "terminal submargin of the superiores and the terminal and inner submargins of the inferiores dusky; the corresponding margins pale," is critical.

Noteworthy among the various interpretations as to the *formosa* of Say is that of Lucas. Lucas redescribed what he believed to be this species, apparently using the same criterion employed by the present writer (that is, the pale margins of the forewing), but his description of the female was based on

an atypical specimen or specimens, as may be seen when reference is made to Say's figure of his species. However, the female assigned to *formosa* by Lucas does display the same pale margins (that is, exterior marginal band of the forewing).

Lucas (*op. cit.*, pp. 744–745) described a closely related species, *thisbe*, and had this species been recognized by later workers the subsequent confusion might well have been avoided. *Thisbe* most closely resembles the true *formosa* in general coloration and size, and though the females are strikingly similar the structure of the male genitalia is quite distinctive. One of the better characters that serve to separate the females is the nature of the exterior marginal band of the forewing, which is infuscated with black in *thisbe* and pale or whitish hyaline in *formosa*.

Lucas (*Op. cit.*, p. 739) described another species, *nephele*, and stated that it might prove to be a variety of *formosa* (as interpreted by Lucas).

Before considering interpretations by subsequent workers, color variation in *formosa* should be discussed. It became obvious to the writer, after studying a large number of specimens which closely fitted Say's original description, that the "submargin" (exterior submarginal dark band) varied greatly in width. In some specimens, both male and female, the width of this band varied from about that indicated in the Say figure to nearly the entire wing, being not only confined to the forewings but also including the hind wings. *In all specimens studied which possessed any degree of variation of the exterior submarginal dark band the exterior marginal band of the forewing was pale, that is, hyaline.* Had workers been aware of this variation, much of the existing confusion might have been avoided. It is interesting to note that if this variation were carried to the extreme, a "dark winged species" would result in which the exterior marginal band of the forewing would be hyaline. Three species of *Pepsis* are known which exhibit this condition (dark brown wings with the exterior marginal band of the forewing hyaline): *P. grossa* Fabricius, 1798, *P. obliquerugosa* Lucas, 1895, and *P. pattoni* Banks, 1944. Moreover, all these species possess identical genitalia in the male, the twelve-segmented antennae, also a characteristic of the male, and other structural similarities to *formosa* of Say, but apparently occupy different distributional areas. Before the actual status of these three can be determined a larger number of specimens must be available for study.

Following the Lucas treatment of the *formosa* problem, Cockerell (*op. cit.*), cognizant of the situation, relegated *nephele* Lucas to the status of a variety of the true *formosa* of Say and complicated matters by renaming the *formosa* of Lucas (for reasons previously discussed) as *pseudoformosa*. Cockerell properly treated *nephele*, but not *formosa* of Lucas. Many investigators continued to regard *thisbe* of Lucas as the true *formosa* of Say. No reasons were given for such synonymy until Salman (1930:121–129) discussed the problem. Salman concluded that the Lucas interpretation of Say's *formosa* was erroneous, and that since *thisbe* and the true *formosa* quite closely resembled one another in size, colorational features of the wings, and distributional data, they must constitute but one species. This decision left the *formosa* of Lucas

without a name, but since Salman regarded *nephele* as a variety of the *formosa* of Lucas the name *nephele* became available for this species.

However, in view of the characters given by Say and of the author's findings with regard to color variation of the wings, particularly that of the exterior submarginal dark band of the forewing, the writer has concluded that the Lucas interpretation of *formosa* was correct, despite the fact that the female upon which Lucas based his redescription of the species was atypical of the destroyed type of *formosa*.

Our California species, *Pepsis thisbe* Lucas, appears to be closely related to *formosa*, but differs in that the subgenital plate of the male is traversed apically by a carinate process and possesses a subapical median tooth and a small subapical transverse carina which joints medially with the tooth. Further, the subgenital plate is not hairy, as in *formosa*, but is only clothed with a fine short pubescence. The females of *thisbe* and *formosa* are remarkably similar and some difficulty may be encountered in their correct determination. The two species in question may be separated by the following key:

1. Males 2
   Females 3
2. Subgenital plate elongate, rectangular, curved downward apically; clothed ventrally with long, black hairs, especially on the median surface .... *formosa* (Say)
   Subgenital plate not elongate, scarcely longer than broad, lateral margins convergently arcuate; clothed ventrally with fine pubescence; apical margin somewhat carinate, obtusely angled; a subapical, low carina extends laterad on either side of subapical median tooth nearly to lateral margins of subgenital plate .... *thisbe* Lucas
3. Forewing with at least the apex whitish hyaline; fore femora clothed with long hairs beneath .... *formosa* (Say)
   Forewing with exterior marginal band, including apex, never clearly whitish hyaline, infuscated with black; fore femora scarcely hairy .... *thisbe* Lucas

In order to avoid any future confusion the writer has deposited a neoholotype male, Mus. Ent. no. 5678, and a neoallotype female, Mus. Ent. no. 5679, of *P. formosa* (Say) in the California Academy of Sciences, both of which were collected in Mesquite, New Mexico.

Banks (1926:202–203) described *Pepsis sayi* from a female from Palmerlee, Arizona, and a male from San Emigdio Canyon, Kern County, California. The writer has examined the allotype male and finds it to be synonymous with *thisbe*. The variation of the subgenital plate, especially with respect to the subapical median tooth, is within the expected range.

But little is known of the biology of *thisbe;* McKenzie (1933:159) reports, under the name of *chrysothemis,* that whole bunches of sound muscat grapes were attacked at Twentynine Palms, San Bernardino County, California.

A male specimen has been studied by the writer which was collected by Mr. P. H. Timberlake at Laguna Beach, Orange County, California, on August 7, 1936. Its characteristics suggest that it might be an F_1 hybrid of a *chrysothemis* × *thisbe* cross. The wings are intermediate, possessing characters of both species. The exterior submarginal dark band of the forewing is characteristic of *thisbe,* whereas the humeral band of the fore and hind wings, as well as the general coloration, are typical of *chrysothemis.* The subgenital

plate is somewhat asymmetrical. It possesses characters of both species, and the posterolateral angles are produced into structures that resemble the sagittae of the genitalia. The morphological nature of the subgenital plate may be described as follows: visible portion trapezoidal, blackish brown, clothed with fine pubescence, posterolateral angles of the plate produced into sagittal-like processes, which are asymmetrical in relation to each other; the right process is somewhat longer and clothed with a few short, black hairs; the left process is but poorly developed and devoid of hair; the median surface of the plate is convexly elevated, being bounded laterally, on either side of the plate, by a low ridge that extends from the anterior visible margin to the posterior margin of the plate; an oblique, subapical transverse carina, beginning near the left posterolateral process and on this lateral longitudinal ridge, extends to the lateral longitudinal ridge of the right side of the plate, where it terminates as a small hump; this oblique subapical carina is much higher on the left side, dropping abruptly in height at the median subapical tooth; subapical median tooth but poorly developed, being formed by the convergence of a carina which extends from a median point on the apical margin of the plate to the mid-point of the subapical, oblique carina.

Pepsis chrysothemis Lucas

Pepsis sommeri, Patton, 1894, Proc. Ent. Soc. Wash., 3:47 (*nec* Dahlbom, *et al.*).

Pepsis chrysothemis Lucas, 1895, Berlin. entom. Zeitschr., 39:731, 739–741, plate 26, figures 35, 43, plate 30, figures 85, 86, 92, plate 31, figure 83, plate 32, figure 133; Dalla Torre, 1897, Cat. Hymen., 8:249; Fox, 1898, Proc. Ent. Soc. Wash., 4:142, 144–145; Viereck, 1906, Trans. Amer. Ent. Soc., 32:232; Banks, 1911, Journ. N. Y. Ent. Soc., 19:237; Brèthes, 1914, Anal. Mus. Nac. Hist. Nat., Buenos Aires, 26:258; Lucas, 1917, Arch. Natg., 83 (5):108, 110, plate 1, figure 27, plate 2, figure 50, plate 3, figure 55; Banks, 1921, Ann. Ent. Soc. Amer., 14:22.

Pepsis cinnabarina Lucas, 1895, Berlin. entom. Zeitschr., 39:782, 804, plate 32, figure 146, plate 33, figures 212, 224; Dalla Torre, 1897, Cat. Hymen., 8:249; Fox, 1898, Proc. Ent. Soc. Wash., 41:141, 148; Viereck, 1906, Trans. Amer. Ent. Soc., 32:231 (=*cinnabarida*, sic!); Brèthes, 1914, Anal. Mus. Nac. Hist. Nat., Buenos Aires, 26:266, 350; Lucas, 1917, Arch. Natg., 83 (5):135, 136, 141, plate 2, figures 71 a, b, c, plate 3, figure 39; Banks, 1919, Bull. Mus. Comp. Zool., Harvard College, 63:248; Banks, 1921, Ann. Ent. Soc. Amer., 14:23; Showalter, 1929, Nat. Geog. Mag., 56:49, plate X, figure 4. (New synonymy.)

Diagnostic characters.—Male. Length 15 to 26 mm. Wings bright, fiery red (though in some older or mechanically damaged specimens coloration paler, then yellowish orange) with a distinct broad, blackish brown, or black humeral band and broad, dark brown exterior marginal band on fore and hind wings; apex of forewing narrowly, but distinctly whitish hyaline; extreme apex of hind wing pale (in some, whitish hyaline). Antennae black. Head, thorax, abdomen, and legs black, clothed with finely appressed iridescent tomentum reflecting blue-green (some specimens display a remarkable bluish or purplish sheen). Subgenital plate trapezoidal, attenuated posteriorly, dark blackish brown, devoid of pubescence, or very nearly so; apical margin bent downward, somewhat carinate, angularly notched medially, posterolateral ends somewhat dentate, evenly rounded; subapical transverse carina short, nearly vertical on posterior surface but sloping forward on anterior surface, laterally bent forward, abruptly decreasing in height, then progressing anterolaterally as a low, thickened ridge which delimits a raised, convex surface. *Female.* Length 16 to 32 mm. Similar to male in coloration. Differs in being more robust and lacking the whitish hyaline wing apices. Pronotum hairy as in male.

Male.—Head subovate, black, finely and irregularly striate, densely clothed with rather short, erect, black hairs and blue-green, iridescent tomentum; ocelli only slightly elevated; hind ocelli bounded laterally by irregular, shallow depression; a distinct but narrow groove runs posteriorly from antennal bases to anterior ocellus; antennal scape black, clothed with finely appressed blue-green tomentum (as is sometimes the pedicel) and basally with a few short, black hairs; flagellum black, glabrous; clypeus somewhat elongate, convex, apical margin evenly concave, entire surface clothed with a few short, black hairs and finely appressed iridescent blue-green tomentum; mandibles dark brown, nearly black, clothed exteriorly with a few long, stout hairs. *Pronotum* vertically produced, shoulders prominent but rounded, clothed quite densely with erect, short, black hairs and blue-green iridescent tomentum. *Propodeum* subcuboidal, wrinkled transversely, clothed with fine, long, brownish hairs (remarkably similar to *thisbe,* but wrinkles not well developed as in that species); horizontal surface convexly produced, especially medially, bears a shallow mediolongitudinal furrow which is traversed by carinate wrinkles; anterolateral humps poorly developed, lateral carina obsolete, replaced by small rounded ridge which extends posteriorly from inner spiracle margin and terminates at base of sloping surface; sloping surface separated from horizontal surface by a well-developed transverse carina which is nearly obsolete medially on either side of central portion, evenly wrinkled transversely. *Wings* bright, fiery red, clothed with iridescent reddish orange and black tomentose hairs; veins amber; extreme apices of forewings whitish hyaline, those of hind wings sometimes infuscated with brown or black; exterior marginal dark band of forewing broad, sometimes extending into closed cells, narrowing posteriorly as approaching axillary excision, darkest along radial vein and apex of marginal cell; humeral band of forewing black, or blackish brown, extending one-third length of median cell (variable); exterior marginal dark band of hind wing as wide as that of forewing, begins before transverse cubital vein, broadens posteriorly to occupy all of second discoidal and anal cells; humeral band blackish, extending fully three-fourths length of median cell. *Legs* similarly clothed as integument, usually devoid of hairs except on coxae where clothed with long, black, erect hairs; femora sometimes clothed with a few short, black hairs; claws dark brown, nearly black, armed basally with a small, well-developed tooth; inner hind tibial spur nearly one half length of basitarsus. *Abdomen* distinctly subpetiolate, spindleform, clothed with iridescent blue-green tomentum, tergites clothed with minute, erect, black hairs, excepting first and last which bear short, black hairs similar to hairs on sternites. *Subgenital plate* trapezoidal, attenuated posteriorly, dark blackish brown, minutely punctate, devoid of pubescence (though in some sparsely pubescent); apical margin bent downward, angularly notched medially, posterolateral projections somewhat dentate, evenly rounded; subapical transverse carina short, nearly vertical on posterior surface, but sloping forward on anterior surface, laterally bent forward abruptly decreasing in height, then extending anterolaterally as a low thickened ridge which delimits a raised, convex surface; area between apical and subapical transverse carinae traversed mediolongitudinally by a low carina, lateral areas so formed are smooth, shiny, sloping to lateral margins of plate.

Female.—Similar to male in coloration, but differs in being more robust, abdomen broader, tergites devoid of hair excepting terminal ones which are clothed similarly as male; depressions laterad of hind ocelli more distinct; clypeus more angularly concave; wing apices black, not whitish hyaline, humeral band narrower, almost obsolete on hind wings, exterior marginal dark band more sharply delimited, somewhat narrower especially posteriorly.

Type locality.—"Mexiko" for both *chrysothemis* and *cinnabarina.*

Recorded California distribution.—MARIPOSA CO.: Coulterville (as *cinnabarina,* Lucas, 1895). "California" (as *cinnabarina,* Dalla Torre, 1897), as *cinnabarina,* Fox, 1898. LOS ANGELES CO.: Claremont, Los Angeles (as *cinnabarina,* Banks, 1919). KERN CO.: as *cinnabarina,* Banks, 1919. SAN DIEGO CO.: San Diego (as *cinnabarina,* Fox, 1898), Poway (as *sommeri,* Patton, 1894).

New California records.—SAN DIEGO CO.: San Diego, 1 ♂, VIII-12-90 (F. E. Blaisdell); 2 ♂♂, VII-6-90 (F. E. Blaisdell); 2 ♂♂, VIII-23-90 (F. E. Blaisdell); 1 ♂, VIII-20-86 (F. E.

Blaisdell); 1 ♂, IX-5-91 (F. E. Blaisdell); 1 ♂, IX-16-90 (F. E. Blaisdell); 1 ♂, VII-11-90 (F. E. Blaisdell); 2 ♂♂, VII-17-20 (W. S. Wright); 1 ♂, VIII-6-21; 1 ♂, VIII-27-26; 2 ♂♂, VIII-26-21; 1 ♂, VIII-25-31; 1 ♂, X-14-26 (C. Searl); 1 ♂, VII-24-21; 1 ♂, VIII-5-21; 1 ♂, VIII-16-21; 1 ♂, IX-13-26 (F. W. Kelsey); 2 ♂♂, VIII-18-21; 1 ♂, VII-10-20 (W. S. Wright); 2 ♂♂, VIII-1-21; 1 ♂, X-17-27 (F. W. Kelsey); 1 ♂, VI-3-28; 1 ♂, VII-30-21;

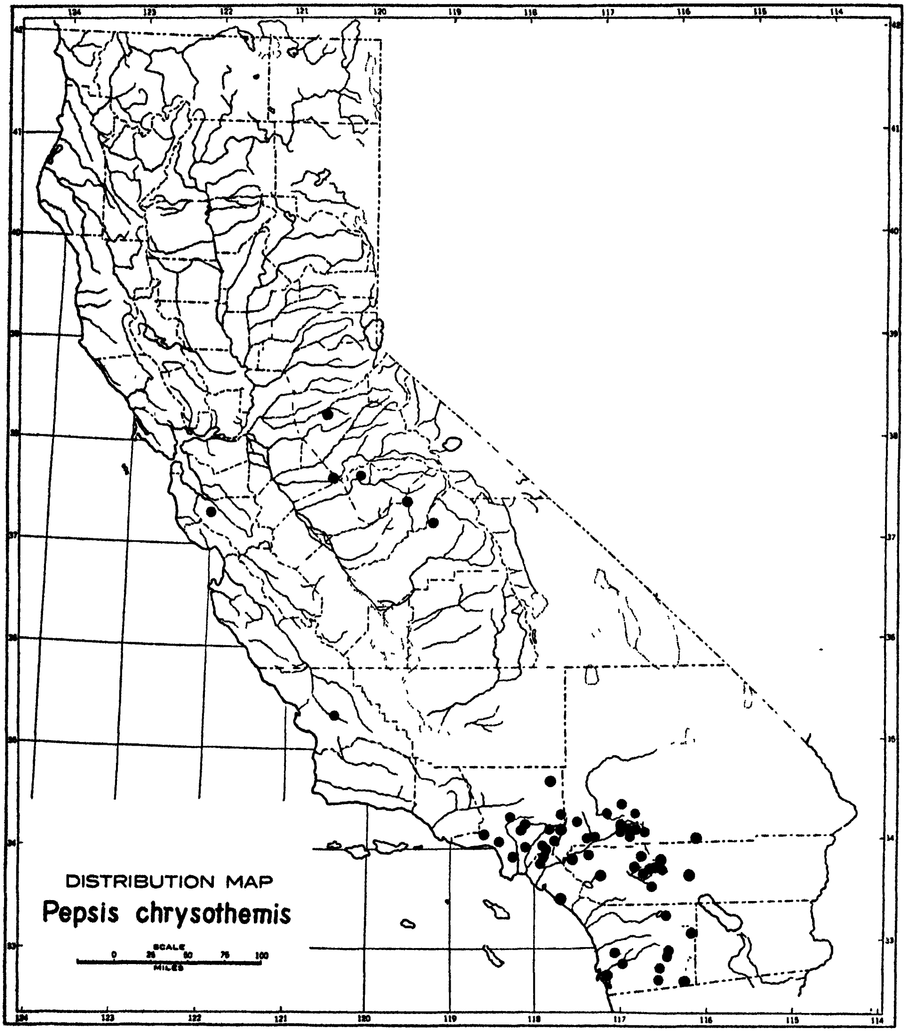

Fig. 4. Distribution of *Pepsis chrysothemis*.

1 ♂, VII-21-31; 2 ♂♂, VII-23-25 (P. H. Timberlake); 1 ♂, VII-24-25 (P. H. Timberlake). San Felipe Valley, 8 ♂♂, 2 ♀♀, VI-24 to 28-20; 4 ♀♀, VI-6-40 (D. J. Raski); 2 ♀♀, VI-7-40 (D. J. Raski); 2 ♀♀, VI-7-40 (H. T. Reynolds); 1 ♀, VI-6-40 (H. T. Reynolds); 1 ♀, VI-7-40 (C. D. Michener); 1♂, 1 ♀, V-20-26 (C. Searl); 1 ♀, VI-7-40 (F. H. Rindge). Pine Valley, 2 ♂♂, VI-21-27; 1 ♀ VI-13-27 (F. W. Kelsey). Morena, 1 ♂, VIII-4-28 (C. Searl). Sweetwater River, 1 ♂, IX-18-34. Warner's, 1 ♂, VIII-2-21. Mission Dam, 1 ♀, VI-21-?. Warren, 1 ♂ (W. M. Wheeler). Poway, 1 ♀, V-12-85 (F. E. Blaisdell); 1 ♀, V-10-85 (F. E. Blaisdell); 1 ♀, VIII-4-85 (F. E. Blaisdell); 1 ♀, IV-12-85 (F. E. Blaisdell). Jacumba, 1 ♀, X-3-25 (J. D. Gunder). ORANGE Co.: Brea, 1 ♂, VIII-26-23 (A. J. Basinger). Carbon Canyon, 1 ♂,

V-14-32 (B. J. Hall). Laguna Beach, 11 ♂♂, VIII-7-36 (P. H. Timberlake). Fullerton, 1 ♂, VIII-11-39 (T. C. Russell). RIVERSIDE Co.: Riverside, 11 ♂♂, VIII-10-36; 1 ♂, VII-7-25 (P. H. Timberlake); 1 ♂, VII-24-36 (P. H. Timberlake); 1 ♀, IV-14-41 (P. H. Timberlake); 1 ♀, V-15-28 (P. H. Timberlake); 1 ♀, V-3-36 (P. H. Timberlake); 1 ♀, V-14-36 (P. H. Timberlake); 1 ♀, IV-23-34 (P. H. Timberlake); 1 ♀, V-5-25 (P. H. Timberlake); 1 ♀, V-1-25 (P. H. Timberlake); 1 ♀, V-6-25 (P. H. Timberlake); 2 ♂♂, X-28-36 (P. H. Timberlake); 1 ♂, VIII-11-27 (P. H. Timberlake); 2 ♂♂, VII-28-36 (P. H. Timberlake); 1 ♂, VII-20-36 (P. H. Timberlake). Corona, 1 ♂, VIII-1935 (E. E. Seibert). Palm Springs, 1 ♂, X-1-23 (J. D. Gunder); 1 ♀, V-5-16 (C. L. Fox); 1 ♀, III-28-16 (C. L. Fox); 1 ♀, IV-18-22 (C. A. Hill); 1 ♀, IV-4-16 (C. L. Fox). San Jacinto, 4 ♀♀, V-29-39 (D. J. Raski). San Jacinto Mts., 1 ♀, V-15-39 (B. Brookman). Piñon Flat, San Jacinto Mts., 1 ♀, V-20-39 (J. H. Dorman). Idyllwild, 1 ♀, VI-30-28 (E. C. Van Dyke); 1 ♂, 2 ♀♀, VII-2-36 (P. H. Timberlake). Blythe, 1 ♂, V-26-45 (E. G. Linsley). Banning, 2 ♀♀, V-28-28 (E. C. Van Dyke). Coachella Valley, 1 ♀, V-9-27 (E. C. Van Dyke). Mt. Thomas, 4 miles north of Anza, 1 ♀, VI-26-26 (W. P. Medlar). Hemet, 1 ♂, VII-4-46 (J. W. MacSwain); 2 ♂♂, VII-26-46 (J. W. MacSwain); 1 ♀, VI-29-46 (W. F. Barr); 1 ♂, VIII-7-46 (J. W. MacSwain); 5 ♂♂, VIII-28-46 (J. W. MacSwain); 1 ♂, VIII-29-46 (J. W. MacSwain). 6 miles south of Hemet, 1 ♂, VII-31-46 (J. W. MacSwain); 1 ♂, VIII-7-46 (J. W. MacSwain). 10 miles southwest of Hemet, 12 ♂♂, VII-19-46 (P. D. Hurd, Jr., and R. F. Smith); 6 ♂♂, VII-20-46 (P. D. Hurd, Jr., and R. F. Smith). Whitewater Canyon, 1 ♂, IX-11-35 (P. H. Timberlake). SAN BERNARDINO Co.: Rialto, 1 ♀, V-7-38 (P. D. Hurd, Jr.); 1 ♂, V-9-38 (P. D. Hurd, Jr.). Cajon Camp, 1 ♀, V-16-36 (J. Corcoran). Victorville, 2 ♂♂, VIII-11-87 (W. G. Wright). San Bernardino, 1 ♀, V-25-37 (J. Skeller). Big Bear Valley, 1 ♀, VIII-13-33 (P. H. Timberlake). Forest Home, 1 ♀, VII-5-36 (P. H. Timberlake). Mill Creek, San Bernardino Mts., 4600 ft., 1 ♂, X-11-36 (P. H. Timberlake). Cushenbury Springs, 5 ♂♂, VIII-16-37 (P. H. Timberlake). Mill Creek Canyon, 1 ♂, IX-23-23 (E. P. Van Duzee); 2 ♂♂, IX-24-23 (E. P. Van Duzee). Oak Glenn Lodge, 1 ♂ (F. S. Daggett). Mojave River at Apple Valley, 1 ♂, VII-29-40 (P. H. Timberlake). Mountain Home Creek, 1 ♂, VIII-19-34 (P. H. Timberlake). 2 miles north of Deep Creek, east side of Mojave River, 1 ♀, V-5-36 (P. H. Timberlake). LOS ANGELES Co.: San Dimas, 14 ♀♀, V-9-36 (K. Holland). Lyttle Creek, 1 ♀, VII-23-25. Exposition Park, 2 ♂♂, VIII-12-27 (J. A. Comstock). Compton, 3 ♂♂, 1942 (W. Kahle). Whittier, 1 ♀ (L. L. Muchmore). Bouquet Canyon, 2 ♀♀, VII-2-37 (N. Waterhurst). Glendale, 2 ♀♀ (E. D. Jones). Los Angeles, 1 ♀, VIII-1936 (G. E. Jules). Claremont, 1 ♀, (E. O. Essig); 1 ♂ (P. H. Timberlake). Puente Hills, 1 ♀, V-9-26 (P. H. Timberlake). Pomona, 1 ♀, V-23-30 (D. W. Clancy). Camp Baldy, 2 ♂♂, VIII-18-29 (P. H. Timberlake); 1 ♀, VIII-24-20 (P. H. Timberlake); 1 ♂, VIII-24-20 (P. H. Timberlake). Carbon Canyon, 1 ♂, V-14-32 (B. J. Hall). Short Cut Canyon, Angeles National Forest, 1 ♀, V-19-18 (V. Duran). Little Rock, 1 ♀, IV-11-36 (G. E. and R. M. Bohart). Mt. Wilson, 1 ♀, VI-1-28 (R. F. Sternitzsky). Voltaire, 1 ♂, IX-5-23 (J. D. Gunder); 1 ♂, IX-6-23 (J. D. Gunder). SAN LUIS OBISPO Co.: 2 ♂♂, 5 ♀♀, VII-1925 (C. Sharp). SANTA CLARA Co.: San Jose, 1 ♀, IX-6-37 (H. Madsen). CONTRA COSTA Co.: Mt. Diablo, 1 ♂, VI-25-41 (C. H. Anderson). CALAVERAS Co.: Mokelumne Hill, 3 ♂♂, August (F. E. Blaisdell); 1 ♀, VII-20-20 (F. E. Blaisdell); 1 ♂, VII-20-24 (F. E. Blaisdell). STANISLAUS Co.: La Grange, 1 ♀ (J. D. Vertrees). MADERA Co.: Crane Flat, Yosemite Natl. Park, 1 ♂, VII-1936 (J. Helfer). FRESNO Co.: Huntington Lake, 7000 ft., 2 ♀♀, VII-18-? (E. P. Van Duzee).

Flight period.— ♂♂ 14 May to 28 October. ♀♀ 28 March to 3 October.

The male and female of *chrysothemis* have long been considered as separate species, but it now appears they are sexes of one and the same species and are accordingly synonymized. Lucas (1895:739–741) described the male as *chrysothemis* and the female (*op. cit.*, p. 804) as *cinnabarina*. Because the name *chrysothemis* was used first for this species in the Lucas monograph (p. 731), and all things being equal, the writer places the name *cinnabarina* in synonymy and retains the name *chrysothemis* for the species.

Recently, Mr. P. H. Timberlake[5] informed the writer that because of frequency of occurrence together in southern California of *chrysothemis*, the male, and *cinnabarina*, the female, they certainly must constitute one species. The writer had also come to the same conclusion by a comparison of the frequency and distributional pattern of the sexes.

Banks (1911:237) considered the *chrysothemis* and *pyramus* of the Fox Collection as the sexes of one species, but just what species he did not state. From the material available to the writer it is obvious that *pyramus* has not been found in California and that the *pyramus* identification of Fox and a specimen labeled *pyramus* by Banks are referable to *thisbe*.

Chrysothemis appears to be closely related to *thisbe*, but differs from that species in that the male subgenital plate lacks a subapical median tooth. The female, *chrysothemis*, has the exterior marginal wing band broad and almost deep black, never paler toward the exterior marginal border as in *thisbe*. The female also differs from that species in that the pronotum is quite hairy, never devoid of hairs or nearly so. The subgenital plate of the male *chrysothemis* bears a rather close similarity to that of *pallidolimbata*, but these two species may be easily placed by the characters given in the key.

Pepsis pallidolimbata pallidolimbata Lucas

Pepsis pallidolimbata Lucas, 1895, Berlin. entom. Zeitschr., 39:733, 745–747, plate 32, figure 162; Dalla Torre, 1897, Cat. Hymen., 8:259; Fox, 1898, Proc. Ent. Soc. Wash., 4: 141, 145; Viereck, 1906, Trans. Amer. Ent. Soc., 32:239; Brèthes, 1914, Anal. Mus. Nac. Hist. Nat., Buenos Aires, 26:259; Lucas, 1917, Arch. Natg., 83 (5):155; Banks, 1921, Ann. Ent. Soc. Amer., 14:23.

Pepsis bequaerti Salman, 1928, Pan-Pac. Ent., 5:23-25. (New synonymy.)

Diagnostic characters.—Male. Length 14 to 22 mm. Wings yellow, or yellowish brown; exterior marginal band of forewing and extreme apex of hind wing usually whitish hyaline, in some faintly infuscated with black; exterior submarginal band of forewing, if present, narrow, pale blackish brown; exterior marginal band of hind wing, if present, narrow, but somewhat broader and more intense than exterior submarginal band of forewing; humeral band of fore and hind wings broad, brown, or blackish brown, extending fully one-third length of median cell in forewing and nearly three-fourths length of median cell in hind wing. Antennae black. Head, thorax, abdomen, and legs black, clothed with finely appressed iridescent tomentum imparting green, blue, purplish (or combinations thereof) sheen (characteristically an indescribably beautiful green); iridescent color in freshly emerged specimens is green, in older individuals purple; head, pronotum, propodeum, coxae, ventral and terminal tergites of abdomen clothed with erect, short, brownish hairs. Subgenital plate trapezoidal, brownish black, lateral margins slightly sinuate; apical margin bent downward forming a sharp, angulate transverse carina with lateral portions thickened, slightly elevated, almost dentate, medial surface concavely depressed; posterior surface of this carina clothed with numerous erect, brownish pubescent hairs; subapical carina erect, sharp, arcuate, nearly as long as apical carina; area delimited by apical and subapical carinae concave, glabrous, smooth and shiny; area anterior to subapical carina convexly produced, somewhat flattened medially, delimited laterally by a low, thickened ridge, clothed with erect brownish pubescence. *Female.* Length 32 to 37 mm. Similar to male, but much more robust. Wing coloration distinctly paler, almost lemon yellow; exterior submarginal band of forewing and exterior marginal band of hind wing, if present, less intense; exterior marginal border of forewing similar to male, but broader. Head, thorax, abdomen, and legs clothed with finely appressed blue-green, usually (rarely purple) iridescent tomentum.

[5] By personal communication.

Male.—Head subovate, black, clothed with finely appressed iridescent blue-green tomentum and numerous short, erect, black hairs; ocelli slightly elevated, hind ocelli bounded basilaterally with a shallow depression; a weak impressed line runs posteriorly from antennal bases to anterior ocellus; antennal scape and pedicel black, clothed with iridescent tomentum as on head, and sometimes with a few short, black hairs; flagellum glabrous, black, or brownish black; clypeus short, distinctly swollen medially, clothed as head, apical margin angulately emarginate; mandibles deep brownish black, paler apically, clothed exteriorly with a few rather short, brownish bristles. *Pronotum* nearly vertical, shoulders prominent but rounded, clothed with blue-green iridescent tomentum and numerous long, black hairs. *Propodeum* subcuboidal, black (sometimes covered with finely appressed blue-green, or green tomentum), clothed with numerous long, blackish brown hairs; strongly wrinkled transversely, wrinkles of horizontal surface and upper fourth of sloping surface carinate; horizontal surface convexly produced, particularly medially, transverse wrinkles best developed over mediolongitudinal furrow and lateral ridges, area between indistinctly wrinkled or coarsely punctate; horizontal surface separated from sloping surface by short, high, carinate, transverse ridge and laterally by terminations of lateral ridges, which are sometimes dentate; transverse wrinkles of sloping surface best developed near upper face and lateral margins, rarely wrinkled or clothed on lower medial half. *Wings* yellow, or yellowish brown; veins pale amber; exterior marginal band of forewing and extreme apex of hind wing usually whitish hyaline (though in some, faintly infuscated with black); exterior submarginal band of forewing, if present, narrow, pale, blackish brown; exterior marginal band of hind wing, if present, narrow, but somewhat broader and more intense than exterior submarginal band of forewing, otherwise whitish hyaline; humeral band of forewing and hind wing brown, or blackish brown, broad, extending fully one-third length of median cell in forewing and nearly three-fourths length of median cell in hind wing. *Legs* similar to integument in coloration, devoid of hair except on coxae where clothed with numerous rather long, brownish black hairs. *Abdomen* spindleform, nearly sessile, rarely subpetiolate as in *chrysothemis;* clothed with finely appressed blue-green (rarely purple, usually green) iridescent tomentum and rather short, black (or blackish brown) hairs except of middorsal segments. *Subgenital plate* trapezoidal, brownish black, lateral margins slightly sinuate; apical margin bent downward forming a sharp, angulate, transverse carina with lateral portions thickened, slightly elevated, almost dentate, medial surface concavely depressed; posterior surface of this carina clothed with numerous erect, brownish pubescent hairs; subapical carina, erect, sharp, slightly arcuate, nearly as long as apical carina; area delimited by apical and subapical carinae concave, glabrous, smooth and shiny; area anterior to subapical carina convexly produced, somewhat flattened medially, delimited laterally by a low thickened ridge, clothed with erect brownish pubescence.

Female.—Very similar to male, but much more robust. Pronotum usually devoid of hairs, as in *thisbe.* Lateral ridges of propodeum terminating posteriorly as distinct dentate teeth, rarely reduced as with the male to carinate humps. Wing coloration much paler, typically lemon yellow; exterior submarginal band of forewing and exterior marginal band of hind wing, if present, less intense; exterior marginal border of forewing similar to male but broader. Head, thorax, abdomen, and legs clothed with finely appressed blue-green, usually green (rarely purple) iridescent tomentum.

Type locality.—"Nordwest-Amerika," for *pallidolimbata;* "Valentine, Presidio Co., Texas," for *bequaerti.*

Recorded California distribution.—SAN BERNARDINO CO.: Twentynine Palms (as *cinnabarina,* McKenzie, 1933).[6]

New California records.—IMPERIAL CO.: Potholes, 2 ♂♂, IV-8-23 (E. P. Van Duzee). RIVERSIDE CO.: Riverside, 1 ♂, VI-12-28 (P. H. Timberlake). Palm Springs, 1 ♀, IV-3-25 (E. C. Van Dyke); 1 ♀, X-1-21 (J. D. Gunder); 1 ♂, IV-18-22 (C. A. Hill). Dos Palmos River, 1 ♀ (G. E. and R. M. Bohart). Thousand Palms, 1 ♀, VII-11-28 (C. Searl). Andreas

[6] Through the courtesy of Mr. P. H. Timberlake the writer has examined a part of the material upon which McKenzie (1933:159) based the record and finds it to have been apparently missidentified.

Canyon, Palm Springs, 1 ♀, IV-11-36 (P. H. Timberlake). Box Canyon, 1 ♂, 1 ♀, IV-13-34 (P. H. Timberlake). 22 miles north of Blythe, 1 ♀, VIII-10-46 (W. F. Barr and P. D. Hurd, Jr.). 20 miles west of Blythe, 1 ♀, VIII-10-46 (J. W. MacSwain). 5 miles south of Midland, 1 ♀, VII-10-46 (W. F. Barr). Coachella, 1 ♂, V-16-17 (E. P. Van Duzee). SAN BERNARDINO Co.: Quail Springs, 1 ♂ (A. L. Melander). Twentynine Palms, 5 ♀♀, VIII-3-33 (P. H. Timberlake); 1 ♀, VIII-3-33 (H. L. McKenzie). Yucca Valley, 19 miles west of Twenty-nine Palms, 1 ♂, VIII-3-33 (P. H. Timberlake). Victorville, 1 ♀, VII-1933 (L. J. Muchmore); 1 ♂, VIII-11-87 (W. G. Wright). Vidal Junction, 1 ♀, VIII-25-46 (W. F. Barr and P. D. Hurd, Jr.). Cushenbury Springs, 5 ♂♂, 1 ♀, VIII-16-37 (P. H. Timberlake); 4 ♀♀, IX-20-36 (P. H. Timberlake). Baldy Mesa, 3 ♂♂, 1 ♀, VII-21-36 (P. H. Timberlake). 8 miles west of Needles, 3 ♂♂ (P. H. Timberlake). Parker Dam, 1 ♂, VIII-10-46 (P. D. Hurd, Jr.). KERN Co.: Inyokern, 1 ♂, VII-18-30 (W. E. Ball). Bakersfield, 1 ♀, VIII-1938 (R. F. Smith). Kernville, 1 ♀ (H. C. Fall). EL DORADO Co.: Salmon Falls, 3 ♂♂, VIII-3-30 (A. C. Brownie). CALAVERAS Co.: Mokelumne Hill, 1 ♀ (F. E. Blaisdell); 8 ♂♂, August (F. E. Blaisdell). INYO Co.: Panamint Mts., 1 ♂, V-29-37 (N. W. Frazier); 1 ♂, V-30-37 (N. W. Frazier); 1 ♂, V-28-37 (N. W. Frazier).

Flight period.—♂♂ 8 April to 9 September. ♀♀ 3 April to 1 October.

The male, *bequaerti,* and the female, *pallidolimbata pallidolimbata,* have been considered as separate species, but the distributional patterns when superimposed strongly suggest that they represent a single species. Moreover, last summer, W. F. Barr and the writer obtained a copulating pair, thereby eliminating doubt concerning the association of the sexes.

Pallidolimbata appears to be most closely related to *chrysothemis* in that the subgenital plate of the male is quite similar, but it differs by having the subapical carina longer, not short and strongly arcuate as in that species. The female in the lack, or very nearly so, of hair on the pronotum and exterior marginal wing border is whitish hyaline, never black.

McKenzie (1933:159) reports that this species (under the name of *cinnabarina*) attacked whole bunches of sound muscat grapes at Twentynine Palms, San Bernardino County, leaving nothing but the dried skins and seeds.

Pepsis pallidolimbata smithi new subspecies

Diagnostic characters.—*Male.* Length 15 to 18 mm. Wings reddish, nearly as red as those of *chrysothemis,* to which it bears a striking superficial resemblance; exterior marginal band narrow, not clearly whitish hyaline, infuscated with black, in some specimens nearly as dark as that of *chrysothemis.* Head, thorax, abdomen, and legs clothed with deep blue-green, almost blue, iridescent tomentum, much darker than that of *pallidolimbata pallidolimbata. Female.* Length 20 to 24 mm. Wings as in male, but exterior marginal band extends farther posteriorly, not much broader than that of male. Head, thorax, abdomen, and legs colored as male.

Holotype male.—California Academy of Sciences Mus. Ent. no. 5680, allotype female, California Academy of Sciences Mus. Ent. no. 5681, and seven paratypes collected by R. F. Smith and the writer in Corral Hollow, Alameda County, California, on July 16, 1946. Additional paratypes are from Tesla (= Corral Hollow), Alameda County, California, collected on September 2, 1942, by R. F. Sternitzsky; Del Puerto Canyon, Stanislaus County, California, July 16, 1946, by R. F. Smith and the writer; and Mount Diablo, Contra Costa County, California, on July 8, 1941, by C. H. Anderson. All but five paratypes, four of which have been deposited in the University of California collection and one in the Museum of Comparative Zoology, Harvard College collection, have been deposited in the California Academy of Sciences collection.

This interesting subspecies differs at once from the typical *pallidolimbata* in the darker wing and body coloration, smaller size of the female, and in the lack, or very nearly so, of the clearly whitish hyaline exterior marginal band on the forewing. It appears to be confined in distribution to the Mount Hamilton range of California. Apparently, *pallidolimbata* is the parent subspecies since it retains the larger size and paler coloration and is distributionally older.

Smithi is named for Dr. Ray F. Smith, of the University of California, whose active interest in the genus led to the discovery of this subspecies.

Pepsis elegans Lepeletier

Pepsis elegans Lepeletier, 1845, Hist. Nat. Ins., Hymen., 3:489; Smith, 1855, Brit. Mus. Cat. Hymen., 3:201; Cresson, 1867, Trans. Amer. Ent. Soc., 1:144–145; Dalla Torre, 1897, Cat. Hymen., 8:252; Fox, 1898, Proc. Ent. Soc. Wash., 4:141, 142, 143; Brèthes, 1914, Anal. Mus. Nac. Hist. Nat., Buenos Aires, 26:245; Lucas, 1917, Arch. Natg., 83 (5):164–165; Banks, 1921, Ann. Ent. Soc. Amer., 14:22; Salman, 1929, Trans. Amer. Ent. Soc., 55: 119–153, 4 plates numbered VI–IX.

Diagnostic characters.—Male. Length 20 to 28 mm. Wings dark brown, faintly violaceous, clothed with blackish brown tomentose hairs. Antennae with at least apical three-fourths orange, or reddish orange. Head, thorax, abdomen, and legs clothed with finely appressed iridescent blue-green (or purple) tomentum. Fourth abdominal sternite bears two oblique rows of apically curved black bristles forming "hair brushes." Subgenital plate somewhat elongate, narrow, lateral margins convergently arcuate, clothed with fine blackish brown pubescence. *Female.* Length 21 to 32 mm. Similar to male, but lacks the "hair brushes" on fourth abdominal sternite.

Male.—Head black, thickly clothed with short, black hairs; ocelli slightly elevated; hind ocelli bounded laterally by a poorly defined depression; an impressed line runs posteriorly from antennal bases to anterior ocellus; antennal scape, pedicel, and basal portion of first segment of flagellum black, rarely clothed with iridescent tomentum or black hairs; remaining portion of flagellum orange, or reddish orange; clypeus strongly swollen medially, apical margin angulately emarginate, clothed as head; mandibles dark brown, clothed exteriorly with a few short, black hairs. *Pronotum* black, vertical, shoulders poorly developed, rounded, thickly clothed with finely appressed blue-green or purple iridescent tomentum and long, black hairs. *Propodeum* black, strongly wrinkled transversely except on sloping surface, densely clothed with finely appressed blue-green tomentum and numerous fine black (or brownish black) hairs; subspiracular humps distinct but rounded; a shallow, mediolongitudinal furrow traverses convexly produced horizontal surface; lateral teeth distinct; sloping surface separated from horizontal surface by a well-developed transverse carina; sloping surface irregularly and rugosely wrinkled (or coarsely punctate). *Wings* dark brown, faintly violaceous, clothed with numerous blackish brown, tomentose hairs (in some specimens a distinct, narrow, but never whitish hyaline exterior marginal band of forewing may be noted). *Legs* colored similarly to integument; coxae clothed with numerous black hairs; some specimens may be sparsely clothed with hair on femora, particularly the fore femora. *Abdomen* spindleform, elongate, clothed with finely appressed iridescent blue-green, or purple tomentum (in certain lights some specimens may display a narrow ferruginous or reddish apical band on the tergites); proximal and apical tergites and all sternites sparsely clothed with short, black hairs; fourth sternite bears two oblique rows of apically curved bristles which form "hair brushes"; fifth sternite is thickly clothed mediolongitudinally, especially posteriorly, with short, black hairs. *Subgenital plate* somewhat elongate, narrow, lateral margins convergently arcuate; apical margin truncate, laterally rounded, clothed with fine blackish brown pubescence.

Female.—Similar to male in coloration and vestiture, but lacks the oblique rows of bristles on fourth sternite and hairs on fifth sternite. Pronotum scarcely hairy.

Type locality.—"Pensylvanie."

Lucas (1895:605–608) considered the *elegans* of Lepeletier (1845:489) as of questionable validity for several reasons. He described a new species *auranticornis* and placed *elegans* in doubtful synonymy with that species. Lucas (*op. cit.*, pp. 605–607) reasoned that the type locality of *elegans* was erroneous because geographically (ecologically?) the *Pepsis* species could not occur there and that, because Lepeletier (*ibid.*) and Smith (1855:201) had stated that the abdominal segments were narrowly ferruginous, the species before him were not *elegans*. It appears to the writer that the species described by Lucas as *auranticornis* may prove to be synonymous with *elegans*. Whether or not the *dubiata* of Cresson belongs in synonymy with either of these species is not certain and therefore must await further study.

Elegans is known from California by a single male specimen collected at San Diego, San Diego County, on August 15, 1921. The validity of the locality label has been questioned, but seems correct.

Elegans is at once separated from all our known California species by its dark brown wings and orange or reddish orange antennae.

Pepsis pattoni Banks

Pepsis obliquerugosa, Fox, 1898, Proc. Ent. Soc. Wash., 4:141, 142, 143 (*nec* Lucas, 1895); Banks, 1921, Ann. Ent. Soc. Amer., 14:22 (*nec* Lucas, 1895).

Pepsis pattoni Banks, 1944, Bull. Mus. Comp. Zool., Harvard College, 94:181–182.

Diagnostic characters.—Male. Length 34 to 40 mm. Wings dark brown, violaceous; a distinct but narrow whitish hyaline exterior marginal band on fore and hind wings. Antennae black. Head, thorax, abdomen, and legs black, clothed with finely appressed iridescent, blue-green tomentum and black hairs, except on tibiae, tarsi, and mid and hind femora. Subgenital plate elongate, rectangular, somewhat attenuated posteriorly, arched downward; apical margin emarginate, laterally rounded; clothed with long, stout, black hairs, especially on median surface. *Female.* Length 38 to 48 mm. Similar to male, but lacks whitish hyaline exterior marginal band on hind wing, and exterior marginal band of forewing is never distinct or whitish hyaline, always infuscated with brown.

Male.—Head black, clothed with numerous, rather long, black hairs and finely appressed iridescent blue-green or purple tomentum; ocelli pale brown, distinctly elevated; hind ocelli bounded laterally by shallow but well-defined depression; a deep groove runs posteriorly from antennal bases to anterior ocelli; anterior ocellus larger than hind ocelli, separated from hind ocelli by less than its diameter; antennae black, twelve-segmented, scape and pedicel clothed with finely appressed blue-green iridescent tomentum; flagellum glabrous, sometimes sericeous, segments concavely depressed medially; clypeus black, distinctly swollen medially, apical margin concave, clothed as head, but hairs are shorter; mandibles dark brown, sometimes black, clothed exteriorly with but a few long, black hairs. *Pronotum* nearly vertical, shoulders prominent, rounded, clothed with finely appressed blue-green (rarely purple) iridescent tomentum and with numerous short, black hairs. *Propodeum* subcuboidal, black, clothed with numerous rather long, fine, brownish black, or black hairs; horizontal surface convexly produced, wrinkled transversely, the wrinkles almost carinate and complete; a shallow, mediolongitudinal furrow traverses raised convexity; lateral ridges rounded, terminating posteriorly as distinctly carinate humps; sloping surface nearly vertical, separated from horizontal surface by a well-developed transverse carina; sloping surface weakly striate. *Wings* dark brown, violaceous (in some lights reflecting rose purple), clothed with very finely appressed blue-green tomentum basally; exterior marginal band of forewing narrow, distinctly whitish hyaline, broader at apex; exterior marginal band of hind wing distinct, whitish hyaline, somewhat broader than exterior marginal band of forewing. *Legs* similarly clothed as thorax, devoid of hairs except coxae and undersurface of

fore femora, where clothed with rather long, black, bristle-like hairs; claws dark brown, almost black, armed basally with a well-developed tooth. *Abdomen* robust, elongately ovate, clothed with finely appressed iridescent blue-green tomentum and rather short, stout, blackish hairs, particularly apically. *Subgenital plate* brownish black, rectangular, somewhat attenuated posteriorly; apical margin emarginate, rounded laterally, thickly clothed with black or blackish brown hairs, which are characteristically bent at tips, on median surface.

Female.—Similar to male in general coloration and placement of vestiture, but considerably more robust. Exterior marginal band of fore and hind wings lacking, never distinctly whitish hyaline. Sloping surface of propodeum transversely wrinkled, the wrinkles carinate in some specimens. Apex of abdomen more thickly clothed with hairs.

Type locality.—"Palmerlee, Arizona."

Recorded California distribution.—LOS ANGELES Co.: "One from mountains near Pomona . . . ," Banks, 1944.

New California records.—RIVERSIDE Co.: Blythe, 1 ♂, IX-25-32 (C. M. Dammers). KERN Co.: Tehachapi Pass, 1 ♀, IX-6-38 (I. McCracken).

Salman (1930: 134–139), after having had the types of *grossa* and *obliquerugosa* compared by Dr. Bischoff of the Berlin Museum, found them to be synonymous, differing but slightly in the nature of the propodeal wrinkles. However, Banks (1944:181–182), after examining a series of *obliquerugosa* Lucas (from Cuba), *grossa* Fabricius (from South America), and our southwestern United States form—formerly called *obliquerugosa* by Fox (1898: 143) and Banks (1921:22) and considered "as *grossa* by Salman,"—decided that the three were separate species. He regarded *obliquerugosa* as restricted to Cuba and separated *grossa* from our southwestern species, which he designated as new, under the name *pattoni*.

The writer has not been able to obtain material enough to permit a restudy of the problem and has therefore followed the conclusion of Banks.

This large, beautiful species is apparently quite rare in California, being known only from the records enumerated above. It does, however, seem quite likely that late fall collecting in the desert areas may provide more information with regard to its occurrence within the State.

Pepsis mexicana Lucas

Pepsis mexicana Lucas, 1895, Berlin. entom. Zeitschr., 39:560, 566–568, plate 24, figure 20, plate 32, figure 131, plate 33, figure 174; Dalla Torre, 1897, Cat. Hymen., 8:257; Brèthes, 1914, Anal. Mus. Nac. Hist. Nat., Buenos Aires, 26:243, 244; Lucas, 1917, Arch. Natg., 83 (5):35, 37, plate 2, figure 10; Banks, 1921, Ann. Ent. Soc. Amer., 14:22.

Diagnostic characters.—*Male.* Length 16 to 24 mm. Wings dark brown, thickly clothed with iridescent blue-green tomentum, especially on forewings, less so on hind wings; exterior marginal band of fore and hind wing distinct, narrowly whitish hyaline. Antennae black. Head, thorax, abdomen, and legs black, thickly clothed with iridescent blue-green tomentum. Subgenital plate brown, black apically, narrow, somewhat attenuated posteriorly; apical margin bent downward, carinate, obtusely angled, sharp; subapical transverse carina erect, angulate, decreasing in height abruptly about its radius from lateral margin of plate, thence extending anterolaterally as a low, thickened ridge, delimiting a raised convex surface; area between apical and subapical carina hollowed out, shiny, lateral portions separated by a low mediolongitudinal carina which disappears posteriorly. *Female.* Length 20 to 28 mm. Similar to male in coloration, but exterior marginal band of hind wing less distinct, somewhat infuscated, never clearly whitish hyaline.

Male.—Head black, thickly clothed with numerous short, black hairs and finely appressed, iridescent blue-green tomentum; ocelli slightly elevated; hind ocelli bounded by a poorly defined depression; a weak impressed line runs posteriorly from antennal bases to anterior ocellus; antennae black, scape and pedicel clothed with finely appressed blue-green tomentum (rarely purple); clypeus swollen medially, apical margin concave, slightly angulate at middle; mandibles dark brown, almost black, clothed exteriorly with a few short, black hairs. *Pronotum* arched posteriorly, shoulders very prominent, thickly clothed with finely appressed blue-green iridescent tomentum and rather long, black hairs. *Propodeum* strongly wrinkled transversely, particularly over convexly produced horizontal surface and lateral ridges; subspiracular tubercles distinct; lateral ridges terminate posteriorly as distinct carinate humps; mediolongitudinal furrow poorly developed; horizontal surface separated from sloping surface by a low but distinct carinate ridge; sloping surface transversely wrinkled, particularly on upper surface; entire surface of propodeum thickly clothed with rather long, fine, brownish black hairs and finely appressed, blue-green iridescent tomentum. *Wings* dark brown, clothed noticeably on forewings with finely appressed iridescent tomentum which reflects blue, green, and purple (or combinations thereof); exterior marginal band of forewing narrow, distinctly whitish hyaline, narrowing posteriorly, disappearing near middle of anal cell; whitish hyaline exterior marginal band of hind wing somewhat broader than that of forewing, but narrowing rapidly posteriorly. *Legs* colored similarly to integument, devoid of hairs except for coxae which are sparsely clothed with long, black hairs; claws dark brown, armed basally with a distinct tooth. *Abdomen* spindleform, distinctly subpetiolate, clothed with finely appressed blue-green iridescent tomentum, apical tergites and all ventral sternites clothed sparsely with short, black hairs. *Subgenital plate* brown, black apically, narrow, somewhat attenuated posteriorly; apical margin bent downward, carinate, obtusely angled, sharp; subapical transverse carina erect, angulate, abruptly decreasing in height about its radius from lateral margin of plate, thence extending anterolaterally as a low thickened ridge delimiting a raised convex surface; area between apical and subapical carina hollowed out, shiny, lateral portions separated by a low mediolongitudinal carina which disappears posteriorly.

Female.—Similar to male in coloration. Exterior marginal band of hind wing infuscated, never clearly whitish hyaline. Pronotum clothed sparsely with short, black hairs. Sloping surface of propodeum finely striated medially, never strongly wrinkled, except on lateral margins.

Type locality.—"Cuernavacca, Mexiko."

California distributional records.—RIVERSIDE CO.: Prado, 1 ♂, VIII-2-33 (C. M. Dammers); 10 miles southeast of Hemet, 5 ♂♂, 2 ♀♀, VII-20-46 (P. D. Hurd, Jr., and R. F. Smith). Hemet, 1 ♂, VIII-28-46 (J. W. MacSwain). Whitewater Canyon, 1 ♂, IX-11-35 (P. H. Timberlake). SAN BERNARDINO CO.: 9 miles east of Goffs, 1 ♂, 1 ♀, VI-22-31 (H. A. Scullen). Goffs, 1 ♂, VI-22-31 (H. A. Scullen). ORANGE CO.: 4 miles east of Laguna Beach, 49 ♂♂, 33 ♀♀, VIII-7-36 (P. H. Timberlake); 6 ♂♂, 4 ♀♀, VIII-7-36 (C. M. Dammers).

Mexicana, being a quite distinctive species, is not readily to be confused with *pattoni*, our only other "black-winged species" possessing black antennae. It differs from that species primarily in having the exterior marginal band of both fore and hind wings whitish hyaline or nearly so, and in possessing a different structure of the subgenital plate in the male and the thirteen-segmented antennae of the male. Moreover, *mexicana* is about one-half the size of *pattoni*.

The above-listed records place this species on our California faunal list for the first time.

Pepsis sherillae new species

Diagnostic characters.—*Male.* Length 22 to 28 mm. Wings dark brown, faintly violaceous, thickly clothed with minute, black hairs; exterior marginal band of fore and hind wings distinct, whitish hyaline, broad at apex, narrowing posteriorly. Antennae black. Head,

thorax, abdomen, and legs black, clothed with finely appressed blue-green (blue usually predominates) iridescent tomentum. Subgenital plate dark brown, almost black, rectangular, slightly narrowed posteriorly; apical margin bent downward, carinate, obtusely angled, though somewhat rounded off medially, subapical median tooth dentate, with a low carina extending on either side of subapical median tooth nearly to lateral margins of plate. *Female.* Unknown.

Male.—Head black, clothed with finely appressed blue-green iridescent tomentum and numerous short, brownish hairs; ocelli black, slightly elevated; hind ocelli bounded laterally by a weak, shallow depression; a distinct impressed line runs posteriorly from antennal bases to anterior ocellus; antennae black, clothed on scape, pedicel, and basal portion of first segment of flagellum with finely appressed blue-green iridescent tomentum; clypeus distinctly swollen, clothed as head, apical margin angulately concave; mandibles dark brown, almost black, clothed exteriorly with long, blackish brown hairs. *Pronotum* arched longitudinally, shoulders poorly developed, rounded, clothed with numerous short, brownish black hairs and finely appressed blue-green iridescent tomentum. *Propodeum* black, subcuboidal, densely clothed with rather long, fine, blackish brown hairs; horizontal surface convexly produced, weakly wrinkled transversely, except over median convexity and lateral ridges; subspiracular tubercles prominent, rounded; propodeal teeth obsolete; sloping surface separated from horizontal surface by a short, erect transverse carina; sloping surface rugosely wrinkled transversely except at extreme base where smooth and shiny. *Wings* dark brown, faintly violaceous, thickly clothed with minute, black hairs; exterior marginal band of forewing and hind wing distinct, whitish hyaline, broad at apex, but narrowing posteriorly. *Legs* colored same as integument; coxae clothed with but a few, rather short, black hairs; claws dark brown, armed basally with a distinct tooth. *Abdomen* similar to *mexicana* but more robust, clothed with finely appressed iridescent blue-green tomentum; apical tergites and all ventral sternites sparsely clothed with short, fine, blackish brown hairs. *Subgenital plate* dark brown, almost black, rectangular, slightly narrowed posteriorly; apical margin bent downward, carinate, obtusely angled, though somewhat rounded off medially, clothed on posterior surface with numerous minute brownish black hairs; subapical median tooth dentate, with a low carina extending on either side of subapical median tooth nearly to lateral margins of subgenital plate; basal portion of subgenital plate so delimited is convexly produced, swollen just before subapical median tooth, densely clothed with blue-green, iridescent tomentum; area between apical and subapical carinae concavely excavated, smooth, shiny, usually glabrous.

Female.—Unknown.

Holotype male (deposited in the University of California Citrus Experiment Station, Riverside, California) collected by P. H. Timberlake eight miles west of Needles, San Bernardino County, California, on June 4, 1938. Paratype male, deposited in the California Academy of Sciences, collected by J. O. Martin at Terlingua, Brewster County, Texas, on May 10, 1922. Paratype male, to be deposited in the University of California collection, collected by J. W. MacSwain twenty miles west of Blythe, Riverside County, California, on June 17, 1946.

Sherillae, dedicated to my wife, is known only from the male, being separated at once from all the dark-winged species known to occur in this country by the presence of the subapical median tooth on the subgenital plate. It runs to the couplet of the Lucas key (1895:560) where *mexicana* and *perthyi* are separated. It differs from *mexicana* in that the wings are not thickly covered with blue-green tomentum and differs from *perthyi* in that the apical margin of the subgenital plate is not right-angled. Both *mexicana* and *perthyi* lack the subapical median tooth on the subgenital plate which is present in the new species. The subgenital plate of *sherillae* is not figured because of its marked similarity to that of *thisbe*.

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A REVISION OF THE CLUNIONINE MIDGES WITH DESCRIPTIONS OF A NEW GENUS AND FOUR NEW SPECIES

(Diptera: Tendipedidae)

BY

WILLIS W. WIRTH

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INTRODUCTION

THIS PAPER is the fourth on the study of the marine midges of the subfamily Clunioninae in which the writer has participated, the three previous reviews having dealt with the larger genera *Clunio, Thalassomya,* and *Telmatogeton* (Stone and Wirth, 1947; Wirth, 1947a, b). Several new species are here added to these genera, and new distributional and biological notes are given for several previously known species. However, emphasis is given to the smaller genera of the subfamily, and a particular attempt is made to restudy them in relation to our concept of the Clunioninae as a group. It seems appropriate, therefore, to present a revision of the higher classification of the Clunioninae at this time, in spite of the fact that our knowledge, especially of the immature stages, is quite limited. For that reason the phylogenetic interpretations which are attempted should be considered as tentative, but they are offered with the hope that critical comments and further study will thereby be stimulated.

Material collected along the coast of California forms the nucleus for the taxonomic work in the present paper, and biological observations in California are reported in detail. Of particular interest was a visit to Point Lobos, Monterey County, California, type locality of *Eretmoptera browni* Kellogg, a species which has not been reported since it was described in 1900. In addition to *E. browni,* a superficially very similar midge which appears to represent a new genus and species, was found with it and in much larger numbers. The new midge was found to be very common in winter along the California coast from Mendocino County to Monterey County. It has probably escaped previous detection because of its small size, although it often covers the intertidal rocks in tremendous numbers.

In working out the distribution of the two species of *Paraclunio* in California, a new species of *Telmatogeton* was discovered, the first record of this genus, as now defined, from the coasts of North America. This species was observed breeding just above high tide level on rocks covered with growths of filamentous green algae supported by a series of large seepage outcrops of fresh water. A somewhat similar preference for fresh water is exhibited by the Hawaiian species of *Telmatogeton* which breed in mountain torrents. Hesse (1934) stated that larvae of *T. sancti-pauli* Schiner could withstand immersion in fresh water for several days, and Tokunaga (1935) was able to rear larvae of *T. japonicus* Tokunaga in fresh water. The writer has also observed in Hawaii a preference by other Clunioninae for coastal habitats where the sea is freshened by stream outlets. Among such species are *Telmato-*

geton japonicus Tokunaga, *Thalassomya setosipennis* Wirth, and *Clunio vagans* Stone and Wirth (Stone and Wirth, 1947; Wirth, 1947a, b).

It seems remarkable that the Clunioninae, a specialized group of Tendipedidae generally restricted to the sea shores, contains members which have been repeatedly found to withstand, or even to prefer, fresh water or water of lower salinity than sea water. This characteristic might be taken to indicate that the group originally branched off from the other Tendipedidae and became adapted to a littoral existence because of considerable competitive pressure in the fresh-water environment. This pressure may then have become alleviated in some manner or other through long periods of time by lessening of the competitive factors. It then would seem possible that those species of Clunioninae in which the adaptation to the salt-water environment had not become rigidly fixed genetically might independently have come to utilize those adjacent fresh-water niches which today are not crowded. This would be especially likely in Hawaii, where the streams are remarkably depauperate.

A second apparently new species of *Telmatogeton* is described, from the Revillagigedo Islands off the west coast of Mexico, further extending the known range of the genus along the west coast of North America.

A new species of *Thalassomya* is described from Florida, forming the first record of this genus from North America. The status of *T. longipes* (Johnson), previously known only from the Galapagos Islands, is clarified from an examination of topotypic material, and the species is here recorded from the Tres Marias Islands.

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Subfamily CLUNIONINAE (Kieffer, 1906) Edwards, 1929

Clunionidae Kieffer, 1906, Ann. Soc. Brux., 30:311–348; 1906, Gen. Ins., 42:3.
Clunionariae Kieffer, 1913, Rec. Ind. Mus., 9:121 (Group of Tendipedinae).
Clunioninae Edwards, 1928, Konowia 7:234; 1929, Trans. Ent. Soc. Lond., 77:370.
Campontiinae Townes, 1945, Amer. Midl. Nat., 34:12.

Adult.—Male antennae never plumose; sense bristles of female antennae absent or rudimentary; antennae often similar in the two sexes. Pronotum completely divided into lateral lobes, postnotum without distinct median keel or furrow; suture between sternopleurite and anepisternite absent or rudimentary. Legs usually very long, especially the hind pair; front coxa enlarged; first segment of front tarsus shorter than tibia; front tibia with spur and hind tibiae with one or two spurs but without combs. Wings often reduced, when present without macrotrichia; vein *m-cu* absent; venation as in Orthocladiinae but R_{2+3} hardly distinguishable. Male genitalia usually rotated or inverted, with dististyles infolded, and without distinct terminal spine (after Edwards, 1929).

Larva.—Antennae nonretractile; third segment not annulated. Labium without paralabial plates; mandibles with a mesal brush, and with one or two outer setae. Anterior prolegs with numerous fine claws; posterior prolegs usually short, with larger curved simple claws. Preanal dorsal papillae of abdomen usually absent, replaced by a single bristle; anal gills usually absent.

Pupa.—Prothoracic respiratory organ a slender tubular process or flattened wedge-shaped lobe or lacking, never a tuft of filaments. Preanal abdominal segment without armature of spines or comb on posterolateral angles, the basal segments usually with patches or lines of shagreening. Terminal abdominal segment modified as a flattened, oblique, sclerotized shield with short, fine ciliae, or bare and bilobed, never with a fringe of long hairs.

Phylogenetic Considerations

The subfamily Clunioninae was originally recognized by Thienemann (1915, 1916) from larval studies and by Edwards (1926) from a consideration of the adults as having a multiple origin from different branches of the *Orthocladius* group of genera. Later, however, Edwards (1929) found a new set of characters including the divided pronotum and absence of the suture between the sternopleurite and anepisternite and he revised the subfamily leaving out several obviously unrelated genera originally included by Kieffer (1913) on the basis of the absence of tibial combs. As thus redefined, the Clunioninae seemed to form a more or less natural group restricted to a marine intertidal habitat. Goetghebuer (1932) followed Edwards' reclassification of adults, but Johannsen (1937) did not feel justified in recognizing the subfamily Clunioninae in his classic memoirs dealing with the immature stages of aquatic Diptera, preferring to include them with the Orthocladiinae.

An attempt has been made by the writer in the present study to reconsider all available characters as derived from a fairly large collection of material and from existing descriptions in an attempt to establish the origin and phylogeny of the Clunioninae. An attempt is made to portray these relationships in a phylogenetic chart in figure 1. Some success has been obtained, particularly with the group of genera including *Clunio*. On the other hand, the genera related to *Telmatogeton* are obviously not closely related to the *Clunio* group, and they may actually have been derived from a different ancestral stock, having come to occupy their present position by evolutionary convergence.

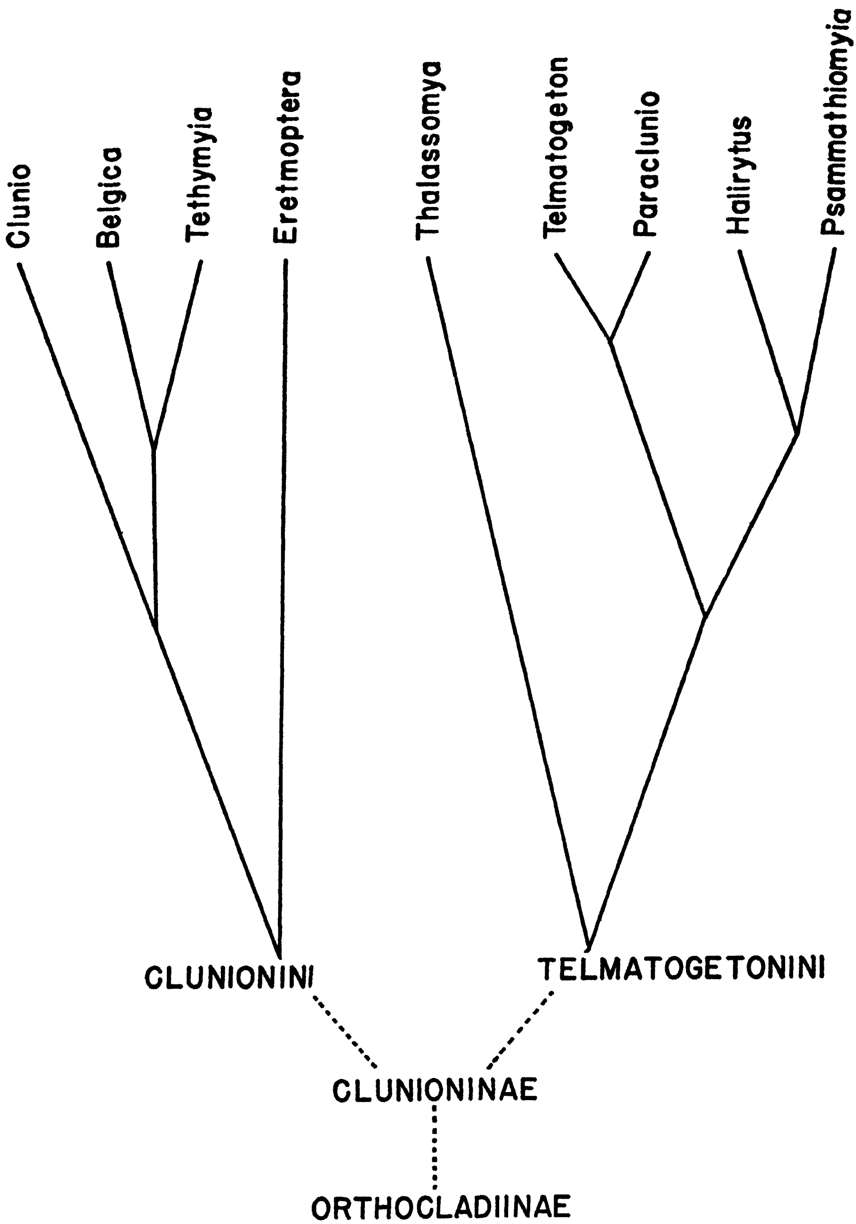

Fig. 1. Phylogenetic relationships of the subfamily Clunioninae.

The present definition of the subfamily on the several strong adult characters proposed by Edwards and accepted by nearly all present workers, as well as the lack of good characters of the immature stages to the contrary, is strongly opposed to the multiple origin idea. The subfamily is therefore considered to be a homogeneous phylogenetic group. Furthermore, as shown in

figure 1, the genera can be grouped readily into two main categories which are here designated as tribes.

The following remarks will serve to explain the combinations of characters used in arranging the chart in figure 1. The subfamily Orthocladiinae, from which the Clunioninae is supposed to have been derived, differs by the fourteen-segmented, usually plumose antennae in the male; five- to eight-segmented antennae in the female; pronotum never divided; a distinct suture between anepisternite and sternopleurite; front coxa not enlarged; a comb of free spinules or fine bristles nearly always present on inner side of distal end of hind tibia; male genitalia not inverted, the dististyles usually with a distinct terminal spine; female genitalia blunt.

The Clunioninae appears to fall quite readily into two main categories. The first and perhaps the least removed basically from the ancestral Orthocladiinae is grouped around the oldest genus *Clunio* and may be given the tribal designation Clunionini. This is a group exhibiting several combinations of variation or reduction of wings, antennae, and palpi, characters which usually form the basis for the recognition of genera. Other quite stable characteristics of the Clunionini are the simple leg structure, the fourth tarsal segment being cylindrical and the fifth never trilobed; the male genitalia moderate to large in size and the dististyles distinctly triangular in profile; the female abdomen rounded, without ovipositor. The known larvae possess premandibles with lateral teeth and the pupae lack prothoracic respiratory horns and have the last segment of the abdomen bare and bilobed.

The tribe Clunionini at present is composed of four genera, of which only *Clunio* is large and widespread. This genus is remarkable for the extreme sexual dimorphism. The males possess functional wings with peculiar venation, and long eleven-segmented antennae, whereas the females are wingless, with short five- or seven-segmented antennae. The palpi are one-segmented in the male, vestigial in the female. *Eretmoptera* is a puzzling genus, similar in some respects to certain marine Orthocladiinae (*Spaniotoma*, subgenus *Smittia*, including *Trichocladius*). The presence of a distinct but very much reduced tibial comb (fig. 2, *j*, p. 158) places it in an anomalous (and perhaps primitive) position in the Clunioninae. The long, three- or four-segmented palpi, the four-segmented (♀) or six-segmented (♂) antennae, the straplike reduced wings in both sexes, and the pointed ninth tergite of the male further characterize the genus. The remaining genera, *Belgica* and *Tethymyia*, are similar with respect to the wings which are vestigial in both sexes and with respect to the truncate ninth tergite of the male; but in *Tethymyia* the antennae are seven-segmented and the palpi one-segmented, while in *Belgica* the antennae and palpi are each four-segmented.

The second and more specialized group of Clunioninae, which is here designated as the tribe Telmatogetonini, includes those species which are usually fully winged, the legs long, antennae seven-segmented in both sexes, the male genitalia very small and the female abdomen tapered. The immature stages of the known representatives are quite distinctive: the pupa bears a flattened, oblique, terminal, sclerotized shield at the apex of the abdomen and prominent

prothoracic respiratory horns, and the larva has the premandibles short with a broad, truncated, trilobed apex.

The genus *Thalassomya* stands quite distinct from the other genera in this second tribe, and is characterized by fully developed wings and strong flight, long four-segmented palpi, legs with the fourth segment cordate, the fifth simple, and the male dististyles pointed at apex.

The four remaining genera form a well-defined group in which the palpi are short and one- or two-segmented, the fourth tarsal segment cordate and the fifth segment strongly trilobed, the male dististyles ovoid or rounded in outline, and the female usually with a well-developed, long and sharply tapering ovipositor. The two genera with fully developed wings are quite closely related, the western North American genus *Paraclunio* being separated from the widespread and large genus *Telmatogeton* principally by the striking modifications of the fore legs. The two genera with reduced wings, *Halirytus* and *Psammathiomyia,* are less well known, the former having wings and halteres minute, and the latter having wings about as long as the thorax.

KEY TO THE TRIBES AND GENERA OF CLUNIONINAE

ADULTS

1. Hind tarsi with the second segment not longer than third; all tarsi with the fourth segment cylindrical and simple, the fifth simple and never trilobed; antennae four- to eleven-segmented, often with sexual dimorphism; eyes usually hairy; male genitalia moderate to large; female abdomen rounded caudad (Clunionini) 2
   Hind tarsi with the second segment longer than third; all tarsi with the fourth segment cordiform, the fifth simple or deeply trilobed at tip; antennae seven-segmented in both sexes; eyes bare; male genitalia small; female abdomen tapered (Telmatogetonini) . . 5
2. (1) Second hind tarsal segment much shorter than third, the fifth segment slightly bilobed; wings fully developed (♂) or absent (♀); antennae usually eleven-segmented (♂) or seven-segmented (♀) (world-wide coasts) . . . . 1. *Clunio*
   Second hind tarsal segment subequal to third, the fifth segment simple; wings straplike or practically absent, similar in the two sexes; antennae four- to seven-segmented 3
3. (2) Wings straplike, reaching to fourth segment of abdomen (♂♀), halteres present; ninth tergite of ♂ genitalia in form of a pointed pubescent lobe caudad; (palpi long, three- or four-segmented; antennae six-segmented (♂) or four-segmented (♀); apex of hind tibia with three long hairs in addition to spur) (California; South Georgia Island) . . . . 2. *Eretmoptera*
   Wings vestigial, not reaching to abdomen (♂♀); halteres absent; ninth tergite of ♂ genitalia broad and truncated caudad 4
4. (3) Palpi short, one-segmented; antennae seven-segmented (♂♀); ♂ dististyles broad at base, tapering to rounded apex, without setae (apex of hind tibia without apical hairs, but with well-developed spur) (coast of California) . . . . 3. *Tethymyia*
   Palpi longer, four-segmented; antennae four-segmented (♂♀); ♂ dististyles narrowed proximad, the distal portion expanded, apex with a distinct point and a patch of setae on dorsomesal face (Antarctic Region) . . . . 4. *Belgica*
5. (1) Fifth tarsal segment simple or slightly bilobed (world-wide coasts) . . 5. *Thalassomya*
   Fifth tarsal segment deeply trilobed at tip 6
6. (5) Both sexes fully winged 7
   Both sexes brachypterous 8
7. (6) Legs unmodified; hairs of legs weak (coasts of Pacific and Indian Oceans) 6. *Telmatogeton*
   Front legs of ♂ modified, the femora swollen with an angular projection near apex which

interlocks with a basal projection of the tibia; hairs of legs strong, sometimes flattened as appressed scales (Pacific Coast of North America) .... 7. *Paraclunio*

8. (6) Wings about as long as thorax; halteres present (Europe) ...... 8. *Psammathiomyia*
Wings and halteres minute or absent (Sub-Antarctic Region) .... 9. *Halirytus*

LARVAE

1. Antennae five-segmented; premandibles with lateral teeth; maxillae broader than long, the palpi segmented; mentum with a lateral pair of subbasal setae (Clunionini) 2
Antennae four-segmented; premandibles with distal teeth or apex entire; maxillae not broader than long, the palpi nonsegmented; mentum without setae (Telmatogetonini) 4
2. (1) Color of integument bluish or purplish; second antennal segment much shorter than proximal segment; labrum with a median sclerotized epipharyngeal bridge 3
Color of integument greenish or whitish; second antennal segment about as long as proximal segment; labrum without a median sclerotized epipharyngeal bridge .... 1. *Clunio*
3. (2) Antennae with proximal segment 1.5:1; premandibles with four teeth; mandibles with five teeth; mentum with nine teeth, the median tooth rounded; pre-anal papillae with a two- or three-haired tuft .... 3. *Tethymyia*
Antennae with proximal segment 2:1; premandibles with three teeth; mandibles with six teeth; mentum with eleven teeth, the median tooth cleft; preanal papillae with a four-haired tuft .... 4. *Belgica*
4. (1) Frontoclypeal suture absent; premandible with broad flattened lobe with an appressed hyaline frayed veil .... 5. *Thalassomya*
Frontoclypeal suture present; premandible with three blunt distal teeth, without hyaline veil .... 6. *Telmatogeton*; 7. *Paraclunio*

PUPAE

1. Prothorax without prothoracic respiratory horns; terminal abdominal segment without flattened, oblique, sclerotized, terminal shield (Clunionini) 2
Prothorax with prothoracic respiratory horns present; terminal abdominal segment with a flattened, oblique, sclerotized, terminal shield (Telmatogetonini) 3
2. (1) Abdominal sternites with rows of spinules on posterior margins; sheaths of gonostyles with sharp-pointed apices .... 1. *Clunio*
Abdominal sternites without rows of spinules on posterior margins; sheaths of gonostyles without sharp-pointed apices .... 2. *Belgica*; 3. *Tethymyia*
3. (1) Dorsal sclerite of terminal abdominal shield without fringe of fine hairs; prothoracic respiratory horn wedge-shaped or cylindrical .... 5. *Thalassomya*
Dorsal sclerite of terminal abdominal shield with fringe of fine hairs; prothoracic respiratory horn wedge-shaped .... 6. *Telmatogeton*; 7. *Paraclunio*

Tribe CLUNIONINI

Adult.—Antennae variable, four- to eleven-segmented, the male usually with several more segments than the female; palpi variable, one- to four-segmented; eyes usually hairy. Wings usually reduced, functional only in males of *Clunio*. Legs with simple structure, second segment of hind tarsus not longer than third, the fourth segment of all tarsi cylindrical, the fifth never trilobed; tarsal claws simple. Male genitalia moderate to large in size, the dististyles triangular in profile. Female abdomen rounded, without ovipositor.

Larva.—Antennae short, five-segmented, the proximal segment 1.5 to 2 times as long as broad; premandible with three or four lateral teeth; maxillae much broader than long, bilobate distally, palpi small and three-segmented with an adjacent palpuslike sensory disc; mentum with nine to eleven teeth, a lateral pair of hairs near base. Other characters of head, and of body, as in subfamily.

Pupa.—Prothoracic respiratory horns lacking; last segment of abdomen bare and bilobed, with sheaths conforming to the shape of the genitalia, never in the form of an oblique, flattened, sclerotized, terminal shield.

1. Genus **Clunio** Haliday

Clunio Haliday, 1855, Nat. Hist. Rev., 2:62; Chevrel, 1894, Arch. Zool. Exp., 28:583; 1913, *ibid.* 51:501; Kieffer, 1906, Gen. Ins., 42:4; Goetghebuer, 1914, Ann. Biol. Lacustre, 7:165; Thienemann, 1915, Arch. Hydrobiol., Suppl. Bd., 2:468; Edwards, 1926, Proc.

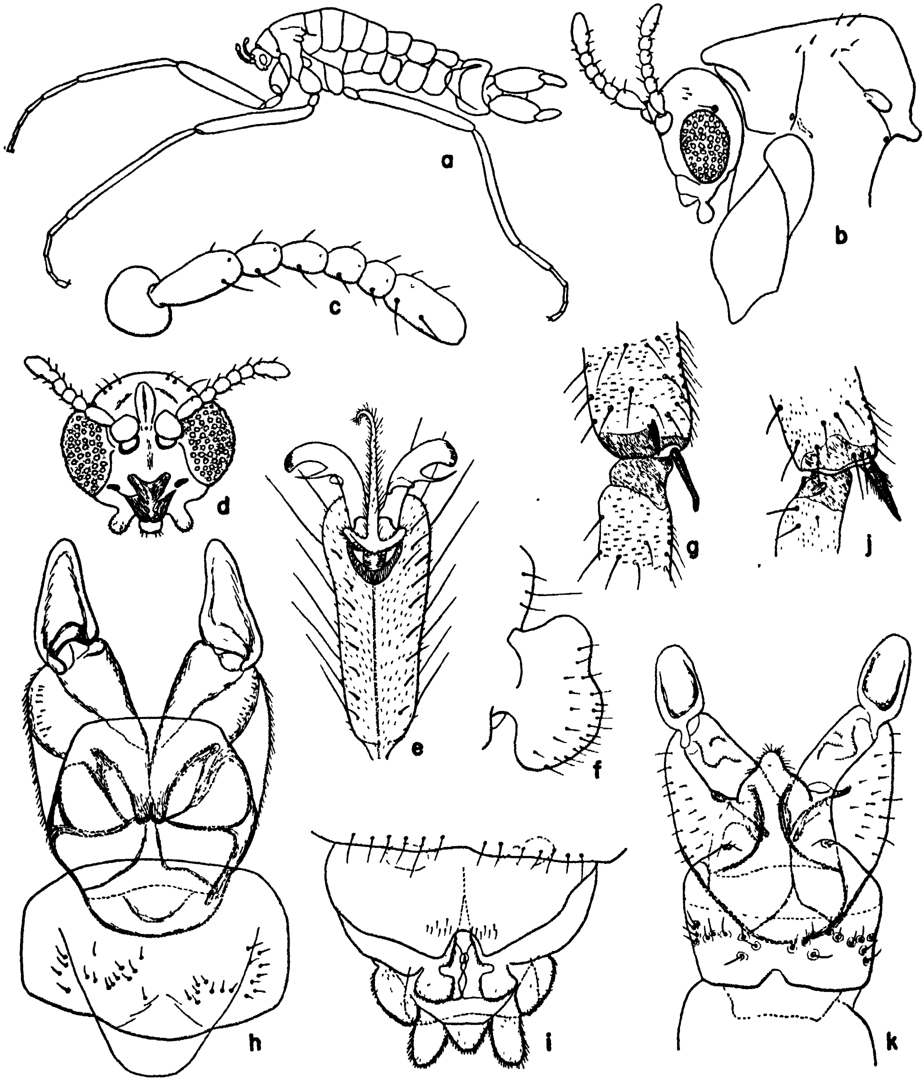

Fig. 2. *Tethymyia aptena, a–i; Eretmoptera browni, j–k, a,* male; *b,* head and thorax of male; *c,* antenna; *d,* head, cephalic aspect; *e,* left front tarsus of male; *f,* female cercus; *g, j,* femorotibial articulation; *h, k,* male genitalia, dorsal view; *i,* female genitalia, ventral view.

Zool. Soc. Lond., 51:785; 1929, Trans. R. Ent. Soc. Lond., 77:370; 1931, Dipt. Pat. & S. Chile, pt. 2, f. 5, p. 304; Tokunaga, 1933, Philipp. Jour. Sci., 51:88; 1938, Annot. Zool. Japan, 17:125; Williams, 1944, Proc. Haw. Ent. Soc., 12:170; Stone and Wirth, 1947, Proc. Ent. Soc. Wash., 49:202.

Genotype: *Clunio marinus* Haliday, 1855 (monobasic).

The paper published by Stone and Wirth (1947) contains a brief review and diagnosis of the genus, with keys to the known species.

Clunio marshalli Stone and Wirth

Clunio marshalli Stone and Wirth, 1947, Proc. Ent. Soc. Wash., 49:214.

This species was described from specimens breeding among the barnacles near the water line of a boat anchored in Biscayne Channel, Dade County, Florida, and observed running around a conch partially exposed at low tide on a sand flat adjacent to Biscayne Channel. Through the kindness of William F. Buren, seven ♂♂ were received from material taken in a light trap at the Key West, Florida, Naval Hospital, Dec. 10, 1947.

2. **Eretmoptera** Kellogg, 1900

Eretmoptera Kellogg, 1900, Biol. Bull., 1:82; Kieffer, 1906, Gen. Ins., 42:5; Schaeffer, 1914, Bull. Brooklyn Mus., 2:91; Edwards, 1926, Proc. Zool. Soc. Lond., 51:789; 1931, Dipt. Pat. & S. Chile, pt. 2, f. 5, p. 304.

Eretmoptera browni Kellogg
(Fig. 2, *j*, *k*)

Eretmoptera browni Kellogg, 1900, Biol. Bull., 1:81.

This species was described from males, females, and a female pupa collected at Point Lobos, California, and has not been reported since. It was collected by the writer only once, at the type locality, on January 4, 1948, in spite of repeated searches up and down the California coast from Point Cabrillo to Point Lobos. At the latter place it was outnumbered about ten to one by the widespread *Tethymyia aptena,* which it superficially resembles very much in size, general appearance, and habits. Quantities of the matted growth of green algae (*Ulva, Enteromorpha,* etc.) which blanketed the higher intertidal levels of the slanting rocky headlands, were searched carefully for midge larvae and pupae, but although numerous immature stages of *Tethymyia* were collected, none were found which could be attributed to *Eretmoptera.* When the writer returned to Point Lobos on February 11th, the algal covering of the rocks had practically all died, dried out, and disappeared; the adults of *Tethymyia* were rather scarce, a few stragglers hatching out of algae remaining in cracks and along margins of tide pools, while no *Eretmoptera* were to be seen. At this time the scavengers, *Canace* sp. (Canaceidae), were very common, swarming everywhere over the ragged patches of algae.

It does not seem necessary to add to the very excellent descriptions and figures given by Kellogg (1900), other than to figure the male genitalia (fig. 2, *k*) from a different aspect for purposes of comparison with that of *Clunio* (Stone and Wirth, 1947, plate 17) and *Tethymyia* (fig. 2, *h*). In addition to some details of the genitalia such as the shape of the dististyles, the shape of the hind tibial spurs (fig. 2, *j*) allies *Eretmoptera* with these Clunionines more than with *Trichocladius,* as suggested by Edwards (1926, p. 789). However, many points of similarity, such as the shape of the four-segmented palpus, general conformation of the legs and tarsal structure, including the presence of from three to five closely set bristles in a rudimentary comb, as

well as general aspect of the male genitalia, seems to raise the possibility that *Eretmoptera browni* is intermediate between the Clunioninae and *Tricho-cladius* of the Orthocladiinae.

It might be noted here that a 336-acre tract embracing Point Lobos was made into a California State Park Reserve in 1933. An excellent account of the topographical, climatic and biotic features of the reserve was published by Grinnell and Linsdale (1936). The writer is greatly indebted to Warden Raleigh A. Wilson for his interest and coöperation during the brief periods of the present study.

Eretmoptera murphyi Schaeffer

Eretmoptera murphyi Schaeffer, 1914, Bull. Brooklyn Mus., 2:91; Edwards, 1926, Proc. Zool. Soc. Lond., 51:789; 1931, Dipt. Pat. & S. Chile, pt. 2, f. 5, p. 234.

This species was described from two females taken by Murphy on South Georgia Island in January and February, 1913. Edwards (1926) questioned the generic assignment of this species, and suggested its identity with *Belgica antarctica,* but a close perusal of Schaeffer's description (1914) does not support this view. Characters of *murphyi* which would allow its assignment to *Eretmoptera* are the 4-segmented palpi, the 6-segmented antennae, wings straplike and reaching to the fourth abdominal segment, inconspicuous female external genitalia, and the simple tarsal claws. The bare eyes and 6- rather than 4-segmented antennae are the principle features differing from *Eretmoptera browni.* As suggested by Schaeffer, an examination of the males will be necessary to place this species correctly, and it will be extremely desirable to check closely the presence or absence of a tibial comb and the exact condition of the fifth tarsal segment, details of which were omitted by Schaeffer.

3. Genus **Tethymyia** Wirth, new genus[1]

(Figs. 2, 3)

♂.—Eyes pubescent. Face bare, clypeal region not distinct; mouthparts reduced, maxillary palpus a single small segment. Antennae seven-segmented; first segment enlarged, bare; second and seventh segments elongate, four to six subspherical; antennae often six- or eight-segmented, the weak or variable point of segmentation apparently at the basal portion of the distal segment; distal segments each with several short bristles. Vertex produced forward between eyes, with a few small setae near eyes.

Pronotal lobes small, widely separated, bare. Mesonotum poorly developed, overhanging the head anteriorly, with few bristles. Pleura reduced; coxae large; legs long and slender, without strong bristles; tibial spurs slender, one on each leg, combs absent; tarsal segments cylindrical, the fifth simple; claws simple and curved, rather blunt, with hyaline preapical seta; pulvilli absent; empodium long and pectinately plumose. Wings vestigial, visible only under high magnification; halteres also reduced, appearing as a heavily sclerotized stub off posterior margin of pleura.

Abdomen long and slender, successive segments undergoing torsion, the genitalia thus being rotated up to about 100° either to right or left. Genitalia prominent: the basistyles ovoid; the dististyles folded inwards in repose, triangular in outline with bluntly rounded apices; ninth tergite large, extending over half the length of basistyles, with truncated posterior margin. Aedeagus reflexed in resting position, with apex directed cephalad, but articulating on heavily sclerotized parameres which pierce mesal margins of basistyles to permit a rocking movement dorsad; base of eighth sternite also heavily sclerotized. Vestiture of entire genitalia of dense pubescence.

[1] Greek: *Tethys* (a sea goddess) + *myia* (a fly).

♀.—Similar to ♂ in characters of head, thorax, wings and legs. Abdomen stout and saclike; apex blunt, without prominent ovipositor. Last tergite and sternite truncated caudad; a pair of short triangular cerci in lateral position. Genital segments with dense pubescence.

Genotype: *Tethymyia aptena* Wirth, new species.

Tethymyia aptena Wirth, new species

A small light grayish species with seven-segmented antennae and one-segmented palpi, vestigial wings and simple tarsi.

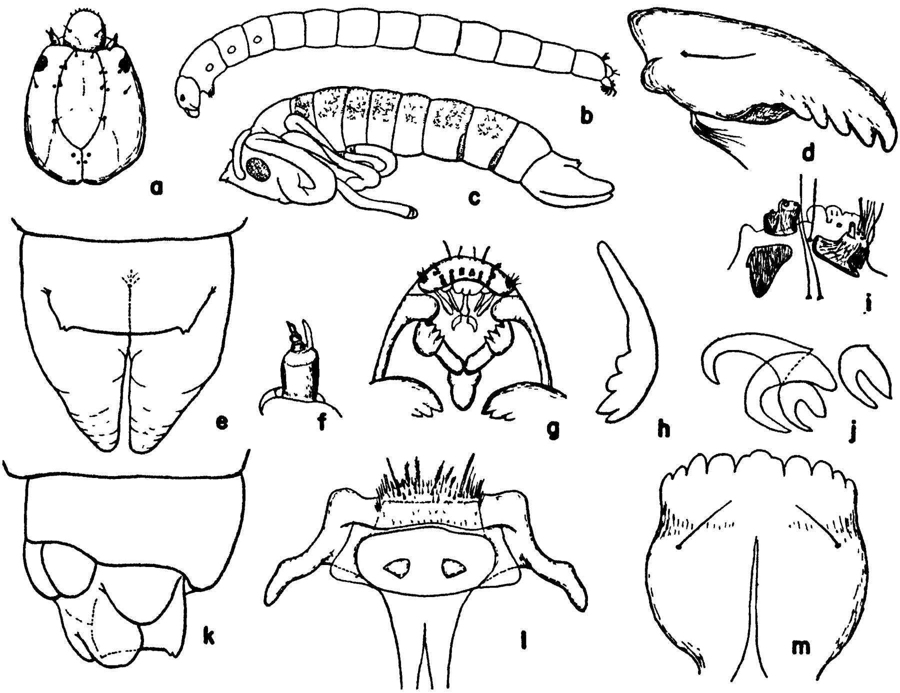

Fig. 3. *Tethymyia aptena*, immature stages. *a*, Larval head, dorsal view; *b*, larva, lateral view; *c*, male pupa, lateral view; *d*, larval mandible; *e*, male pupa, dorsal view of terminal abdominal segment; *f*, larval antenna; *g*, larval labrum, ventral view; *h*, larval premandible; *i*, larval maxilla; *j*, larva, claws of posterior prolegs; *k*, female pupa, lateral view of terminal abdominal segments; *l*, larval hypopharynx; *m*, larval mentum.

♂.—General color light grayish, including legs, antennae, face, and unpigmented portion of abdomen. Posterior portion of mesonotum and abdominal tergites and sternites with dark bluish-gray pigmentation, each tergite with two lateral pairs of prominent light spots. Heavily sclerotized structures, such as vertex, first antennal segment, tip of palpus, mesonotum, pleural sclerites, coxae, trochanters, articulations of segments of legs, and all of genitalia, dark amber brown.

Head (fig. 2, *b*, *d*). Vertex extending forward by width of first antennal segment ahead of eyes, the median frontal carina in profile forming a straight line with face and clypeus; vertex, occiput, and frontal carina heavily sclerotized. Antennae (fig. 2, *c*) with proximal segment set in concavity between frontal carina and eye margin; first segment about twice the diameter of succeeding segments, subspherical; second segment about twice as long as broad at apex, tapering slightly basad; third to penultimate segments subspherical, ultimate segment slightly more than twice as long as broad, with incomplete segmentation on proximal third to form a more or less apparent eighth segment (in some specimens, antennae

with only six complete and a seventh incomplete segment); distal segment slightly but roundly tapering to tip; antennal ratio 20:30:15:15:14:12:30. Proximal antennal segment bare of setae, the distal segments or apparent segments each with two setae about as long as diameter of segment; distal segments with numerous sensoria, also with apices more or less pigmented. Maxillary palpi a single subspherical to ovoid segment with long pubescence only; darkly sclerotized. Mouthparts otherwise prepresented only by a posterior median unsclerotized lobe as long as palpi, with a few short apical setae, representing the labium, and a greatly reduced, slightly sclerotized pair of mandibles on the posterior margin of the membranous lobelike clypeolabrum.

Thorax (fig. 2, *a*, *b*). Pronotal lobes bare. Mesonotum slightly ridged in midline cephalad; anterior margin with a distinct median cleft, the portion in front of level of suture extending dorsocephalad from wing insertion bare but heavily sclerotized, the posterior portion sclerotized laterad of a line of four short subdorsal setae, the mesal portion unsclerotized, with an irregular median row of six short setae. Scutellum poorly differentiated, bare. Pleura bare; anterior spiracle located just in front of, and at lower extremity of a well-defined suture extending dorsad from dorsal limit of fore coxa; alar sclerites reduced; wing a pubescent membranous lobe about size and shape of last antennal segment arising on mesopleural suture; haltere a bare, heavily sclerotized, truncated stub off posterior margin of pleura; posterior spiracle on suture just below haltere.

Legs (fig. 2, *a*, *e*, *g*). Coxae large and heavily sclerotized, the anterior margins with well-developed bristles; trochanters heavily sclerotized and setose. Leg ratios as follows:

	Cx	Tr	F	Ti	T_1	T_2	T_3	T_4	T_5
Fore leg	30	15	90	90	40	20	16	10	12
Mid leg	35	12	110	125	40	20	16	10	12
Hind leg	30	10	110	110	38	20	18	9	11

Segments from femora distad with uniform sparse vestiture of short setae arranged more or less in longitudinal rows; integument of femora and tibiae densely set with minute transverse sclerotized plates each bearing a comb of usually three to six minute setulae; tarsi with dense setulae set singly. Femora slightly thickened dorsoventrally, slightly clavate basally; tibial and tarsal segments cylindrical, the fifth tarsal segment as in figure 2, *e*.

Abdomen with tergites and sternites sparsely set with strong setae arising from light-colored ocellate spots. Genitalia as in figure 2, *h*.

Size variable, length 1–2 mm.

♀.—Similar to ♂ in color and general features. Body stouter, abdomen robust, subcylindrical, slightly tapering caudad to the bluntly rounded apex. Legs as in the ♂ but shorter, ratios as follows:

	Cx	Tr	F	Ti	T_1	T_2	T_3	T_4	T_5
Fore leg	24	10	60	65	23	12	10	7	9
Mid leg	28	10	75	75	23	10	9	6	9
Hind leg	20	10	80	72	23	10	8	5	7

Abdomen not heavily sclerotized, tergites and sternites with fine sparse setae on anterior segments, setae becoming stronger and more numerous caudad up to and including seventh sternite and eighth tergite. Eighth sternite (fig. 2, *i*) with posterior margin deeply cleft mesad and densely pubescent except for a small transverse patch of about 15 minute setae anterior to the cleft; bearing a pair of flattened, quadrate, appressed, partly-detached, pubescent lobes on caudomeson. A pair of subovoid, pubescent cerci (fig. 2, *f*) subequal in size to lobes of ninth sternite arising laterad from junction of eighth and ninth segments. Ninth sternite tapered and rounding caudad bearing a bluntly pointed, pubescent, median lobe and a pair of thumblike, pubescent, caudally directed, lateral lobes surpassing the median point by half their length. Ninth tergite in form of a truncated, posterior, pubescent lobe about half again as broad as long. Two small, oval, sclerotized spermathecae without prominent ducts. A large internal whitish mucus gland filling much of the posterior portion of the abdomen, similar in shape to that figured by Keilin (1912) for *Belgica antarctica*.

Larva (fig. 3, *b*). Length (mature), 4 mm.; head capsule, 0.33 mm. long by 0.24 mm. broad. Body whitish, mottled with bluish to violet pigmentation; head dark brown, almost blackish; hooks of anterior pseudopods light amber, of posterior pseudopods black.

Head (fig. 3, *a*) pyriform, broadest near base, tapered and downcurved cephalad, the clypeolabrum a distinctly narrowed and dorsally convex region. Frons about a third as wide as, and two-thirds as broad as head, narrowly shield-shaped, half as broad as long, broadest at middle, pointed caudad and narrowly truncated cephalad at the frontoclypeal suture which is about two-fifths as long as broadest portion of frons. Antennae (fig. 3, *f*) borne laterally at level of frontoclypeal suture, about half as long as clypeolabrum in dorsal view; basal segment large and barrel-shaped, about half again as long as broad and about three times as broad as second segment; distal segments combined about two-thirds as long as first segment and progressively narrowed, the second and third segments transverse, the fourth slightly longer than broad and the fifth a minute conical setiform structure; a slender, simple, hyaline membranous Lauterborn's organ borne on membrane at tip of first segment and extending to about tip of fourth segment; no hairs or setae apparent on antennae. Clypeolabrum distinctly set off from posterior main portion of head by a deep frontoclypeal suture, about as broad as long in dorsal outline, rounded cephalad and very convex dorsad, no distinct clypeal sclerites present; bearing a sublateral pair of fine setae about halfway back. A pair of sublateral setae borne on frons just behind frontoclypeal suture, and two pairs of fine setae on lateral margins of anterior half of frons. Vertex with a pair of inner setaless tubercles and a lateral pair of fine setae at level of middle and hind frontal setae, and a pair of setae near frontal suture at level of posterior two thirds of frons; two pairs of setaless tubercles on each side of the median posterior arm of epicranial suture. A pair of irregular eyespots borne laterally at anterior third of head, and a pair of small setae borne ventrolaterad on head diagonally in front and below eyespots and a pair of setaless tubercles diagonally below and behind eyespots.

Labrum (fig. 3, *g*) as seen from below convex, the lateral margins strongly sclerotized on proximal two-thirds, this sclerotized framework being arched mesac and ventrad with a blunt heavy sublateral projection for the articulation of the dorsal or proximal ends of the premandibles, and forming a narrow ventromesal bridge to the ventroposterior margin of which in the epipharyngeal region are fastened a median, broad, trilobed, spoonlike plate and two sublateral pairs of curved bladelike spines. The anterior margin of the labrum bearing on its dorsal aspect two submedian pairs of downcurved spines, the lateral pair heavier, laterad of which are two or three pairs of minute tubercles; ventrally a row of three pairs of short, stout, flattened, laterally plumose, down-curved spines, above the lateromost pair of which are two additional smaller but similar spines in a vertical line, and at the extreme lateral margin with a clump of about five down-curved spines. Posteromesal surface of labrum in the epigustal region with a **Y**-shaped sclerotized bridge with the median arm heavier and directed caudad. Premandibles (fig. 3, *h*) slender, on the posterior side with two rather pointed distal teeth, two shorter, blunter, subapical teeth, and somewhat tapered on the long, slender, basal portion which is articulated at about basal fourth to the labrum-epipharynx proper. Mandible (fig. 3, *d*) rather slender, with five blunt teeth on distal third, with a long seta on ventral margin near base and a tuft of about six long hairs on inner side near base. Maxilla (fig. 3, *i*) membranous, irregular in outline, an irregular mesal lacinia bearing distally a dense mesal tuft of long setae and a long cylindrical peglike structure; a few minute pegs and spines on the trilobed membranous distal margin of the maxilla between the lacinia and a laterodistal sclerite bearing a short bilobed palpus, the two lobes of unequal length, each roughly cylindical and bearing a few minute conical pegs on the distal membrane; a long, slender seta between palpus and mesal sclerite, and proximad to this a pair of long single or double setae with closely approximated, basal tubercles. Mentum (fig. 3, *m*) about as broad as long, a median line of weakness on basal half or two-thirds, distal margin truncate to slightly rounded, a broad rounded or slightly trilobed median tooth and four progressively narrower rounded teeth on each side; a sublateral pair of long hairs over halfway to apex. Hypopharynx (fig. 3, *l*) lying closely appressed to the dorsal side of mentum, its distal portion of about the same shape and

breadth as distal margin of mentum; connected laterally by two lateroposteriorly directed, slender, supporting sclerites with a very fine transverse median sclerotized median bridge supporting the flattened, membranous portion bearing a distal fringe of long, plumose hairs on ventral margin and a flattened, median, heavily shagreened lobe curved dorsad.

Thoracic and preapical abdominal segments without evident setae. Prothoracic pseudopod shallowly bilobed at tip, each lobe with a crown of hooklets ranging from minute retrorse spinules on posterior and lateral sides to long, slender, hook-tipped spines at anterodistal margin. Last (ninth) abdominal segment rounding dorsoposteriorly, with a pair of short stout pseudopods borne ventrolaterally; each pseudopod with about fifteen strongly curved unserrated hooks (fig. 3, *j*) in three irregular rows at apex, those of distal row longest and least curved; a pair of long slender double or triple hairs borne directly on dorsoposterior extremity of ninth segment, another pair of shorter single hairs at apex of a pair of blunt moundlike caudal protuberances arising between the pseudopods.

♂ *Pupa* (fig. 3, *c*).—Length, 2–2.5 mm.; exuvia sclerotized pale amber in cephalothoracic region and on genital cases, the pupa darkening with the developing imago within. Cephalic region with mesal point in profile, the point deeply sclerotized; antennal cases arising on each side of point and curving posterolaterad over eyes; a sublateral pair of fine setae arising just laterad of bases of antennal cases.

Prothorax without trace of respiratory horns; dorsum of thoracic region slightly carinate mesad; with an anterior pair of single and a posterior pair of triple submedian fine setae. Leg cases closely appressed and four-times folded, curved ventrolaterad to attain fourth abdominal sternite; the wing cases lateral in position and above the leg cases, about three times as long as greatest breadth on proximal third, the apex tapered and sharply pointed, reaching about halfway ventrad and caudad on second abdominal segment.

Abdomen with tergites heavily shagreened on first seven segments, each tergite with two pairs of clear spots, an anterior lateral pair pointing obliquely inward, a posterior submedian pair pointing obliquely outward toward the lateral pair; posterior margins of tergites with many fine hooklets; eighth tergite with very fine shagreening only. Sternites with shagreening restricted to broad posterior bands on sixth and seventh segments. Ninth tergite a broad posteriorly truncated lobe slightly broader than long, with a pair of closely approximated, bluntly conical, brownish spines at each extreme distolateral corner. Sheaths of gonostyles quite large, extending past ninth tergite by its length, meeting mesad in a straight line, the two lobes fusing dorsad just behind apex of ninth tergite but cleft ventrad nearly to base of ninth segment, their apices bluntly pointed toward midline and devoid of spines, hairs or other structures (fig. 3, *e*).

♀ *Pupa.*—As in the ♂, but genital segments (fig. 3, *k*) as follows: Ninth tergite and sternite of about equal length, the tergite truncated distally as in the ♂ with a pair of blunt conical brownish spines on distolateral corners; sternite in form of two blunt rounded lobes, a pair of low, moundlike submedian lobes also on eighth sternite; a distinct lobelike subtriangular lateral sclerite on base of ninth segment encasing the ♀ cerci.

Holotype ♂, *allotype* ♀.—Point Lobos, Monterey County, California, January 4, 1948, W. W. Wirth; deposited in the California Academy of Sciences. Paratypes: 300 ♂♂, 9 ♀♀, same data as types; 55 ♂♂, Feb. 11, 1948, W. W. Wirth.

Other material examined.—Point Cabrillo, Mendocino County, Calif., Feb. 5, 1948, J. W. MacSwain, 11 ♂♂; Feb. 15, 1948, W. W. Wirth, 110 ♂♂, 7 ♀♀; Bodega Head, Sonoma County, California; Jan. 14, 1948, T. Thatcher and J. W. MacSwain, 60 ♂♂, 1 ♀; Feb. 7, 1948, W. W. Wirth, 120 ♂♂; Point Lobos, Monterey County, Calif., Jan. 4, 1948, W. W. Wirth, 25 larvae, 20 pupae.

Related most nearly to *Belgica antarctica* Jacobs, possessing in common with it, simple tarsi of similar structure, vestigial wings similar in both sexes, male genitalia with ninth tergite truncated caudad, and female abdomen rounded caudad, with a large mucus gland; but differing from it in that the palpi are one-segmented rather than four-segmented, the antennae are seven-segmented rather than four- or five-segmented, and the male dististyles are

shaped differently. According to the descriptions of Rubsaamen (1906) and Keilin (1912, 1913) the larvae and pupae of *Tethymyia aptena* resemble those of *Belgica antarctica* in many respects, notably the bluish or purplish color of the larvae, and the absence of prothoracic respiratory horns and the shape and length of the wing cases of the pupa. On the other hand the larvae bear the following differences:

	Tethymyia	*Belgica*
Antenna, prox. seg.	1.5:1	2:1
Premandible	4 teeth	3 teeth
Mandible	5 teeth	6 teeth
Mentum	9 teeth, the median rounded	11 teeth, the median cleft
Preanal papillae	2- or 3-haired tuft	4-haired tuft

While the labrum of *Tethymyia* is quite similar to that of *Belgica* in general plan (compare fig. 3, *g* with Keilin, 1913, fig. 4), the numbers and shape of the setae, etc., are quite distinct.

During the winter months this species was very common as far as the writer was able to collect along the California coast. But during March the numbers decreased rapidly and by early summer the species practically disappeared, not to reappear until the winter rains and cool weather began in November and December.

4. Genus **Belgica** Jacobs, 1900

Belgica Jacobs, 1900, Ann. Soc. Ent. Belg., 44:106; Kieffer, 1906, Gen. Ins., 42:5; Rubsaamen, 1906, Voy. du Belgica, Zool., 8:77; Keilin, 1912, Paris C. R. Acad. Sci., 154:723; 1913, Deuxieme Exped. Antarct. Francaise, 6:217; Edwards, 1926, Proc. Zool. Soc. Lond., 51:789; 1931, Dipt. Pat. & S. Chile, pt. 2, f. 5, p. 234.

Genotype: *Belgica antarctica* Jacobs, 1900 (by subsequent monotypy).

Two species were described by Jacobs (1900) in the genus *Belgica, antarctica* and *magellanica*. Rubsaamen (1906) erected the genus *Jacobsiella* for *magellanica,* which has since (Edwards, 1928) been synonymized with *Halirytus*. *B. antarctica* was described from material taken by Racovitz during the voyage of the Belgica from the Straits of Gerlache, and has since been recorded from the same straits by Enderlein (1909) from collections of the "Deutsche Sud-Polar Expedition (1901–1903)" and by Keilin (1912, 1913) from collections of the French expedition of the Pourquoi-Pas.

According to Keilin (1913), who has given an excellent account of this species, *B. antarctica* has been found only in the Straits of Gerlache, at about 65° South latitude, and is the only tendipedid and one of the very few insects to be found in the true Antarctic Region. Larvae of *Belgica* were collected by Racovitz and described by Rubsaamen, who however believed the adult to be a sciarid and the tendipedid-type larvae to be incorrectly associated. The abundant material of all stages, including both larvae, and pupae in transformation, examined by Keilin, proved that *Belgica* was a tendipedid and that Racovitz had correctly associated his adults and larvae. *B. antarctica* appears to be most closely related to *Tethymyia aptena,* as has been discussed under that species above.

Tribe TELMATOGETONINI

Adult.—Antennae seven-segmented in both sexes; palpi variable, one- to four-segmented; eyes bare. Wings fully developed and functional (usually) or reduced, similar in the two sexes. Legs with second segment of hind tarsi longer than third, the fourth segment cordate or the fifth segment strongly trilobed; tarsal claws simple or cleft in the male. Male genitalia small, the dististyles pointed at apex or ovoid in outline. Female abdomen tapered, with prominent downpointed cerci or a prominent, long and sharply tapering ovipositor.

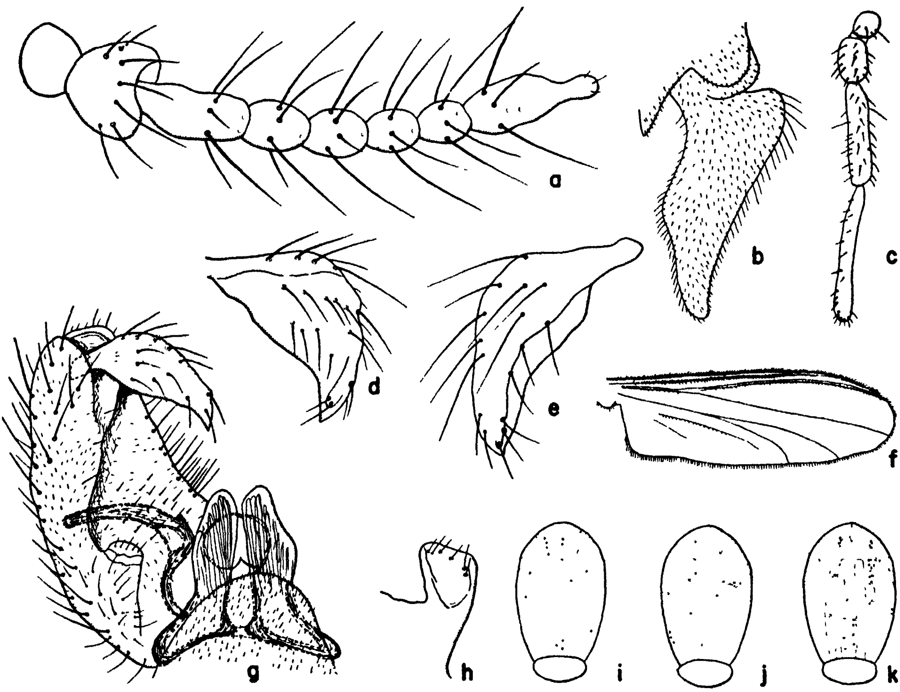

Fig. 4. *Thalassomya bureni, a–c, f–g, k; T. longipes, d–e, h, j; T. maritima, i. a,* Antenna; *b,* female cercus; *c,* palpus; *d,* male dististyle, Tres Marias specimen; *e,* same, Galapagos specimen; *f,* wing; *g,* male genitalia, dorsal view; *h,* dorsal lobe of male basistyle, Tres Marias specimen; *i–k,* mesonotal patterns.

Larva.—Antennae short, four-segmented, the proximal segment about 1 to 1.5 times as long as broad; premandibles with simple lobelike apex with veil or with three blunt distal teeth; mandibles with five to seven teeth; maxillae usually longer than broad, the distal apex with a single lobe, the palpus stout and nonsegmented; mentum with nine to thirteen teeth, without lateral setae. Other characters as in subfamily.

Pupa.—Prothorax with tapered wedge-shaped or tubular respiratory horns present; terminal abdominal segment modified in a flattened, oblique, sclerotized, terminal shield.

5. Genus **Thalassomya** Schiner, 1856

Thalassomya Schiner, 1856, Verh. Zool.-bot. Ver., 6:218.

Thalassomyia Schiner, 1868, Novara Reise, Zool., 2:24 (emendation); Edwards, 1924, Ent. Mo. Mag., 60:204; 1926, Proc. Zool. Soc. Lond., 51:786; 1929, Trans. R. Ent. Soc. Lond., 77:371; Wirth, 1947, Proc. Hawn. Ent. Soc., 13:118.

(?) *Campontia* Johnston, 1830, Zool. Jour., 3:325 (*genus dubium*).

Scopelodromus Chevrel, 1903, Arch. Zool. Exp., 1:1.

Galapagomyia Johnson, 1924, Zoologica, 5:86.

Genotype: *Thalassomya frauenfeldi* Schiner, 1856 (monobasic).

Genotypes of Synonyms: *Campontia eruciformis* Johnston, 1830 (*Campontia*); *Scopelodromus isemerinus* Chevrel, 1903 (*Scopelodromus*); *Galapagomyia longipes* Johnson, 1924 (*Galapagomyia*); (all by monotypy).

This genus appears to favor warmer coasts, the distribution of the known species being confined to between 25° south and 40° north latitude. Waters of reduced salinity are also preferred at times, especially around harbors and river mouths. Most of the species have been taken in the Pacific Ocean, but one ranges into the Indian Ocean, and the genotype is common around the northeast Atlantic and the Mediterranean. This species has also been taken at Montevideo on the eastern coast of South America, where if its distribution is actually so restricted, it may possibly have been introduced by maritime commerce. The review of the genus by Wirth (1947) containing keys to the species should be used in conjunction with present descriptions and notes.

Schiner's original spelling of the genus (1856) was *Thalassomya,* but he later (1868) changed the spelling to *Thalassomyia,* which has been used by all workers to the present time. However in keeping with Article 19 of the International Rules of Zoölogical Nomenclature, which states that "the original orthography of a name is to be preserved unless an error of transcription, a *lapsus calami,* or a typographical error is evident," it is necessary to use the original orthography, *Thalassomya.*

Thalassomya bureni Wirth, new species
(Fig. 4)

A small dull-brown species closely related to *T. setosipennis* Wirth which it resembles in bearing setae on the posterior wing veins, in the structure of the diststyles and dorsal lobes of the basistyles of the male genitalia, and in the shape of the female cerci, but from which it differs in the shape of the distal antennal segment, in the color pattern of the mesonotum and in the shape of the internal parameres of the male genitalia.

♂.—General color dull brown; the mesonotum and postnotum uniformly dark brown, scutellum somewhat lighter; abdomen dark grayish brown; posterior side of mid coxa blackened; upper margin of pleura, area around wing bases, anterior wing veins, and all of legs yellowish; halteres yellowish white. Viewed from above a pattern of whitish pubescence extends entirely across the anterior third of mesonotum, extending caudad to scutellum as three narrow lines along the median and subdorsal rows of setae (fig. 4, *k*). This pattern is the same as in *setosipennis*, but in the latter the pattern extends into the integument, where the pollenose area is light yellow, the polished area dark brown.

Antennae (fig. 4, *a*) seven-segmented, basal segment about twice the diameter of distal segments, only slightly broader than long; second segment about twice as long as broad, slightly constricted in middle; segments three to six slightly longer than broad, especially third and fourth segments; seventh segment about three times as long as broad at base, distal third sharply constricted, with a long nipplelike tip; each segment with an encircling row of long bristles; ratio of segments 30:40:22:22:19:18:50. Palpi (fig. 4, *c*) long (1.3 longer than antenna) and four-segmented; proximal and third segments subequal in diameter, the second broader, the fourth greatly narrowed and lengthened; ratio 20:30:75:90; bristles long and dense on first two segments, shorter and sparser on third and

quite sparse on fourth. Paraglossae ovoid and bristly, about size and shape of second palpal segment. Clypeus covered with long bristles throughout; vertex covered with shorter bristles.

Pronotum narrowly divided dorsally into very narrow lateral lobes each bearing about fifteen long setae. Mesonotal setae in pattern as in figure 4, *k*. Scutellum convex, about half again as broad as long, with about thirty-five long setae, these longest laterad where they are about as long as length of scutellum; postscutellum about size of scutellum, flattened, darker in color and bare.

Wings covered with microtrichiae, appearing smoky gray-brown; costa and radial branches infuscated with light brown; costa, R, R_1, and R_{4+5} densely set with strong dark setae; base of M, Cu, and 1st A also with a few setae; squama and posterior wing margin fringed with long fine hairs. Venation as figured (fig. 4, *f*).

Legs long; ratio of segments as follows:

	Cx	Tr	F	Ti	T_1	T_2	T_3	T_4	T_5
Fore leg	15	6	45	62	40	12	8	3	5
Mid leg	15	5	73	66	32	10	8	3	5
Hind leg	18	5	73	87	46	20	12	3	5

Femora slightly thickened basally, tibiae slender, tarsal segments cylindrical except fourth segment cordate; last segment simple; empodium long and thinly plumose; claws simple, anterior claw of fore and mid legs pectinate at tip, others sharp at tip; pulvilli arise from base of each claw as hyaline, lanceolate lamellae about as long as claws. Legs densely setigerous, setae of uneven lengths, the longest on dorsal margins of segments about twice as long as diameter of segment.

Abdomen moderately stout and laterally compressed, all segments with a rather sparse even vestiture of moderate brown bristles, these somewhat stronger on posterior tergites. Male genitalia (fig. 4, *g*) inverted, very similar to that of *setosipennis*, except for the shape of the internal parameres which are markedly curved and sickle-shaped, with the apices directed laterad within the basistyles.

Length, 2.0–3.5 mm.; wing, 1.5–2.5 mm. long by 0.5–0.75 mm. wide.

♀.—As in the male, usually smaller, with wing rather broader in proportion to its length. Abdomen shorter, more markedly compressed laterally and down-curved and rounded distally; cerci (fig. 4, *b*) prominent, stout on basal two-thirds, then abruptly tapered to a pointed, slightly down-curved apex. Genital segments densely pubescent; last sternite with a sparse patch of long yellowish hairs.

Holotype ♂, *allotype* ♀.—Miami Beach, Florida, Dec. 20, 1947, Wm. F. Buren; deposited in the U. S. National Museum. Paratypes: 15 ♂♂, 5 ♀♀, same data as type; also 3 ♂♂, 7 ♀♀, July 11, 1947; 1 ♂, 1 ♀, Oct. 31, 1947; 9 ♂♂, 4 ♀♀, Dec. 15, 1947; 3 ♂♂, 4 ♀♀, Feb. 9, 1948, from Miami Beach; 2 ♂♂, Marathon, Vaca Key, Florida, Nov. 16, 1947; 1 ♂, Key West, Florida, Dec. 10, 1947.

All specimens were collected in light traps by Mr. W. F. Buren, to whom this species is dedicated with pleasure. The Miami Beach light trap was located at the U. S. Quarantine Station on Fisher Island adjacent to a long jetty of large granite boulders at the mouth of Miami harbor. Conditions at the intersection of this jetty with the Atlantic Ocean beach line are similar to those existing at Nawiliwili harbor and Hilo Bay where *T. setosipennis* was found breeding in Hawaii. *T. bureni* is quite closely related to *setosipennis*, and this relationship poses an interesting problem of distribution, in view of their wide separation with the intervening area on the western coast of Central America being inhabited by another species, *T. longipes*, with South Pacific relationships.

Thalassomya maritima Wirth

Thalassomyia maritima Wirth, 1947, Proc. Hawn. Ent. Soc., 13:131.
Thalassomyia pilipes Edwards, 1935 (not 1928), Ins. of Samoa, pt. 9, f. 3, p. 110.

A series of one ♂ and three ♀♀ from Point Ritidian, Guam, June 6, 1945, G. E. Bohart and J. L. Gressitt, collectors, in the collection of the California Academy of Sciences, agrees well with *maritima*. This species was described from Hong Kong, China, and New Caledonia, the present locality lying well within an arc where its occurrence would be expected. The mesonotal pattern is figured for comparison with other species (fig. 4, *i*).

Edwards' (1935) note in the addenda of the Insects of Samoa referring the Honk Kong material collected by Saunders to *T. pilipes* has just come to the writer's attention. The Hong Kong material which was described by the writer as *maritima* in 1947 did not agree at all with Edwards' (1928) original description of *pilipes* from Samoa, and was therefore described as new.

Thalassomya longipes (Johnson)

Galapagomyia longipes Johnson, 1924, Zoologica, 5:86; Edwards, 1926, Ins. of Samoa, pt. 6, f. 2, p. 61; Curran, 1932, Medd. Zool. Mus. Oslo, No. 30:348.
Thalassomyia longipes, Edwards, 1935, B. P. Bishop Mus. Bull., 114:87; 1935, Insects of Samoa, pt. 9, f. 3, Addenda, p. 110; Wirth, 1947, Proc. Hawn. Ent. Soc., 13:136.

Numerous references are available discussing the status of this species, but unfortunately no detailed description has appeared since the original by Johnson (quoted in Wirth, 1947). The writer has been fortunate in securing the loan of two specimens of this species from the Galapagos Islands for study: one ♂ from the series recorded by Curran (1932) from Floreana, Post Office Bay, Nov., 1925; and one damaged specimen (without abdomen) from the California Academy of Sciences collected by M. Willows, Jr., of the Templeton Crocker Expedition on Indefatigable Island, May 6, 1932. From the material the following notes and figures are given to supplement the original description.

Antenna with distal segment tapering, the distal third sharply constricted in a nipple similar to that figured for *bureni* (fig. 4, *a*). About eight long setae on each pronotal lobe; mesonotum highly arched, with the median and subdorsal longitudinal setigerous furrows well defined, the latter broadening posteriorly and forming two very well defined, deep, prescutellar furrows; pollenose pattern not well defined, but appearing in the Indefatigable specimen as in figure 4, *j*; all mesonotal setae strong, their length sebequal to length of scutellum, the latter with about fifteen similar setae. Wing with dense fine setae on costa and radial branches, none on posterior veins; cubital fork very narrow at base, its base at about level of base of R_{4+5} or tip of r-m. Legs with dense vestiture of long fine hairs, the longest of these about twice the diameter of segments, those on hind legs especially long and very fine. Male dististyle as in figure 4, *e*.

From the California Academy of Sciences collection, the writer has had the privilege of examining four specimens of *Thalassomya* from the Tres

Marias Islands about 65 miles off the west coast of Mexico. There were two ♂♂, one ♀, Maria Madre Island, May, 1925, H. H. Keifer; one ♂, Magdalena Island, May 19, 1925, H. H. Keifer. These specimens agree well with the Galapagos specimens of *longipes* in size, mesonotal vestiture, the shape of the dististyle (fig. 4, *d*) and dorsal lobe of the basistyle (fig. 4, *h*) of the male genitalia, and in the wing venation. Minor differences were noted in the vestiture of the legs, on which the bristles were noticeably stouter and darker than in the Galapagos material; the mesonotal pattern was more definite when viewed from above, with a well-defined, semicircular, pollenose area on each humerus on which the integument was of a yellowish rather than a dark brown color. The ♀ cerci were slender and gradually tapering from the base, and the last sternite bore a sparse patch of light yellowish hairs. The pleura of the Tres Marias specimens bear a prominent thickened fold or lobe of the mesepimeron below the wing base which is conspicuously dark in color and was probably what Johnson referred to in *longipes* as "pleura yellow, with a large brown central spot." Abdominal segments with sparse vestiture of strong bristles, these not as dense or long as in *maritima* or *setosipennis,* but more so than in *bureni.*

6. Genus **Telmatogeton** Schiner, 1866

Telmatogeton Schiner, 1866, Verh. Zool.-bot. Ges. Wien, 16:931; 1868, Novarra Reise, Zool., 2:25; Edwards, 1928, Konowia, 7:234; Wirth, 1947, Proc. Hawn. Ent. Soc., 13:145.
Charadromyia Terry, 1913, Proc. Hawn. Ent. Soc., 2:292.
Trissoclunio Kieffer, 1920, Ann. S. Afr. Mus., 17:523.

Genotype: *Telmatogeton sancti-pauli* Schiner, 1868 (Monobasic).

Genotype of synonyms: *Charadromyia torrenticola* Terry, 1913 (*Charadromyia*); *Trissoclunio fuscipennis* Kieffer (*Trissoclunio*); both by original designation.

Since the writer's revision of the genus published in 1947, two additional species have been received and are described below. In the previous paper (p. 153) an attempt was made to divide the thirteen known species of the genus into four groups on the basis of apparent structural and distributional relationships. The species herein described weaken rather than confirm that grouping, the first species falling in group B with *japonicus* Tokunaga and *australicus* Womersley, and the second species combining characters of groups C (as in *simplicipes* Edwards) and D (as in *sancti-pauli* Schiner and *minor* Kieffer). The present species are the first known records of the genus as here restricted from North America.

Telmatogeton macswaini Wirth, new species

(Fig. 5)

A moderate-sized, blackish species with dusky wings; antenna with terminal segment long and narrowly tapering; bristles around eyes moderate in size; legs slender with dense, fine setae, the front femora clavate basally, very slender toward tip, and the tibiofemoral articulation not modified.

♂.—General color brownish-black, the mesonotum, pleura, and postscutellum pruinose black; antennae, legs and scutellum brownish; abdomen grayish pruinose; wings smoky brownish black; halteres white.

Antennae (fig. 5, *d*) seven-segmented; basal segment bulbous, about twice as broad as succeeding segments, with many large bristles about as long as diameter of segment; second

segment about twice as long as broad at tip, constricted at middle; third to sixth segments subspherical; seventh segment about three times as long as broad at base, tapered gradually to a narrow tip, often with tip set off with a slight constriction forming a slender nipple; segments two to six bare; seventh with a circle of four or five long setae at widest portion; last six segments with abundant, minute, hyaline, sensory pits. Ratio of segments 35:35:15:15:15:15:55. Palip two-segmented; first segment oval, swollen, with sparse fine setae; second fingerlike and narrowed, almost bare. Paraglossae prominent, extending past tips of palpi, the apices with dense fine setae. Vertex flattened and slightly hollowed above, emarginate between bases of antennae, with a row of long black bristles encircling the eyes. Clypeus a prominent, transverse, convex sclerite with dense, long bristles.

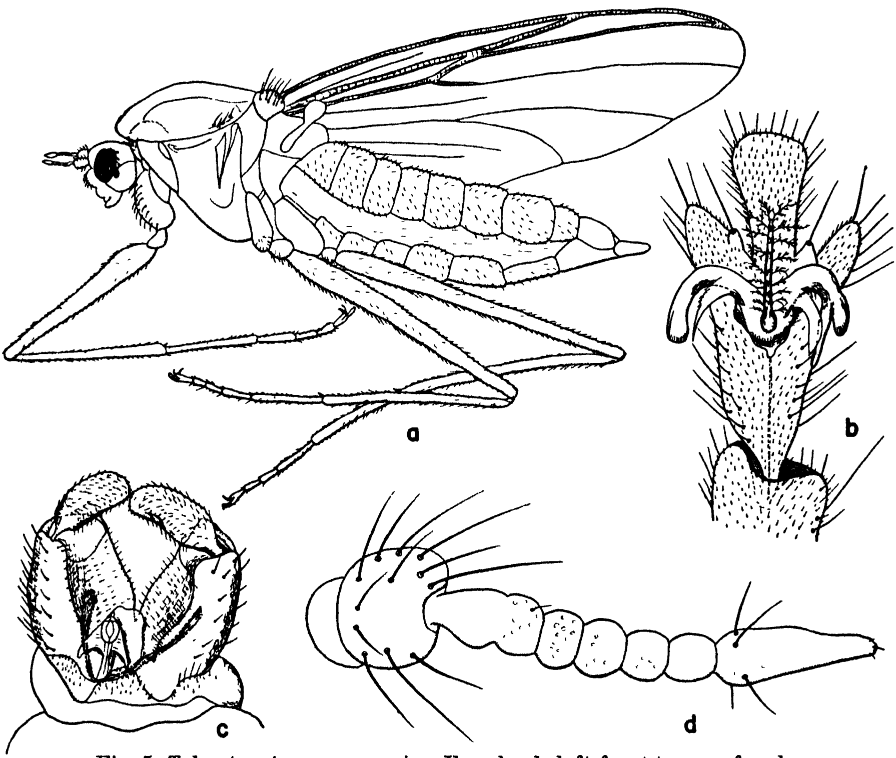

Fig. 5. *Telmatogeton macswaini*. *a*, Female; *b*, left front tarsus of male; *c*, male genitalia, dorsal view; *d*, antenna.

Pronotal lobes each with four to five setae. Mesonotum broad, strongly and narrowly arched anteriorly and overhanging the head; indented at humeral angles, broadening midway and continuing full to wing bases; two short sublateral prescutellar furrows; a few minute setae in each subdorsal row, several in a short vertical row behind humeri, and four or five stronger setae above wing base, the latter group arising from light colored ocellate spots. Scutellum with about twenty long, black setae, the longest about as long as length of scutellum; postscutellum bare.

Wings with venation as in figure 5, *a;* anterior veins thickened and darkened; costa with dense, fine setae; R and R_1 with about fifteen minute setae; R_{4+5} with five to seven minute setae toward tip. Squamae fringed.

Legs long; ratio of segments as follows:

	Cx	Tr	F	Ti	T_1	T_2	T_3	T_4	T_5
Fore leg	20	6	70	60	30	12	7	6	11
Mid leg	20	6	97	70	25	10	6	5	10
Hind leg	20	6	100	80	25	18	8	6	10

Coxae large, with dense, long setae anteriorly; trochanters simple, densely setose below; femora and tibiae slender, the front femora clavate at base, very slender distad. Femora, tibiae, and tarsi with dense, fine bristles throughout. Fifth tarsal segment (fig. 5, *b*) very deeply trilobed, the median lobe nearly as long as proximal section of segment; claws of all tarsi similar, strongly curved from base; anterior claw with flattened pectinate arm only, the tooth vestigial; posterior claw with the sharp inner tooth very long and slender, about twice as long as the flattened pectinate lateral arm.

Abdomen with only sparse, minute setae; ♂ genitalia (fig. 5, *c*) rotated variably to right or left between seventh and eighth segments. Basistyles stout, slightly longer than broad, slightly tapering distad, concave dorsomesally, with numerous short hairs laterad and abundant fine setae mesad; dorsal margin with a low setigerous lobe faintly indicated at base. Dististyles ovoid, flattened, infolded, slightly concave on flexor surface, convex on opposite surface, with abundant fine setae, these directed proximad on flexor surface. Phallosome consisting of two closely appressed pairs of posteriorly arched, hyaline, sclerotized plates arising between bases of basistyles and directed dorsad; inner plates bearing a lateral pair of rounded apical lips; outer plates each with an apical leaflike expansion at level of inner lips closely appressed to inner lips caudad but prominently expanded cephalad as a pair of long recurved lobes. Internal parameres stout, straight, with irregular, capitate apices. Eighth tergite bearing a conical, membranous, pubescent, median lobe and a pair of low, flaplike, setigerous, lateral lobes on posterior margin.

Length, 4.4–5.2 mm.; wing, 3.3–4.4 mm. long by 1–1.3 mm. wide.

♀.—Similar to male in color, vestiture and general characteristics; slightly larger in size (average length about 5 mm.); wings broader (4.8 mm. by 1.5 mm.), surpassing the apex of abdomen. Tarsal claws long, simple, and sharp. Eighth abdominal segment compressed laterally, triangularly tapered in side view, with length about equal to basal heighth; cerci large and ovoid, about half as long as eighth sternite; genital appendages densely pubescent.

Holotype ♂, *allotype* ♀.—Point Cabrillo, Mendocino County, California, Feb. 15, 1948, W. W. Wirth; deposited in the California Academy of Sciences. Paratypes: 15 ♂♂, 24 ♀♀, same data as type; 2 ♂♂, Feb. 5, 1948, J. W. MacSwain.

I take great pleasure in naming this species in honor of Mr. J. W. MacSwain, to whom I am indebted for its first discovery. *T. macswaini* is most closely allied to *japonicus* Tokunaga, which it closely resembles, particularly in the structure of the antennae, wing venation, and male genitalia. It differs in its larger size and especially in the structure of the tarsal claws, those of *japonicus* being of a more generalized asymmetrical type for the genus while those of *macswaini* are unique in the complete loss of the sharp inner arm on the anterior claw of each leg. The phallosome of the male genitalia is also distinctive in the possession of the long recurved anterodorsal lobes similar to those of *Paraclunio.*

Telmatogeton latipennis Wirth, new species

(Fig. 6)

A small, light-colored species with markedly broadened wings; short antennae with prominent sensory setae; bristles around eyes strong; legs slender with sparse fine setae; front femora clavate basally, very slender toward tip, the tibiofemoral articulation not modified; tarsal claws short and asymmetrical; male genitalia with prominent dorsal lobe and setose dorsal margin of basistyle; and a prominent pair of sclerotized setigerous submedian lobes flanking the phallosome.

♂.—Details of coloration not apparent in the much-faded aged specimens available, but the species seems to be a light brown color generally.

Antennae (fig. 6, *c*) seven-segmented, the basal segment enlarged and subcylindrical, about half again as long as broad, with a prominent basal ring of long bristles; distal segments about half the diameter of basal segment, the second segment about twice as long as broad at tip, slightly constricted in middle and tapering basad; segments three to six subequal, each slightly broader than long; seventh segment slightly enlarged basally, tapering to a distinct bare nipplelike tip, about as long as preceding three segments together; segments two to six each with an encircling distal ring of twelve to fifteen prominent basiconic sensillae, the distal segment with scattered sensillae on basal portion; second segment with a long distal bristle, the seventh segment with a similar bristle on basal portion. Ratio of segments 50:30:15:15:15:15:42. Palpi two-segmented, the first segment short and stout, the second segment finger-shaped and narrowed, with scattered setae. Eyes with an encircling row of moderately long bristles; clypeus with numerous long bristles.

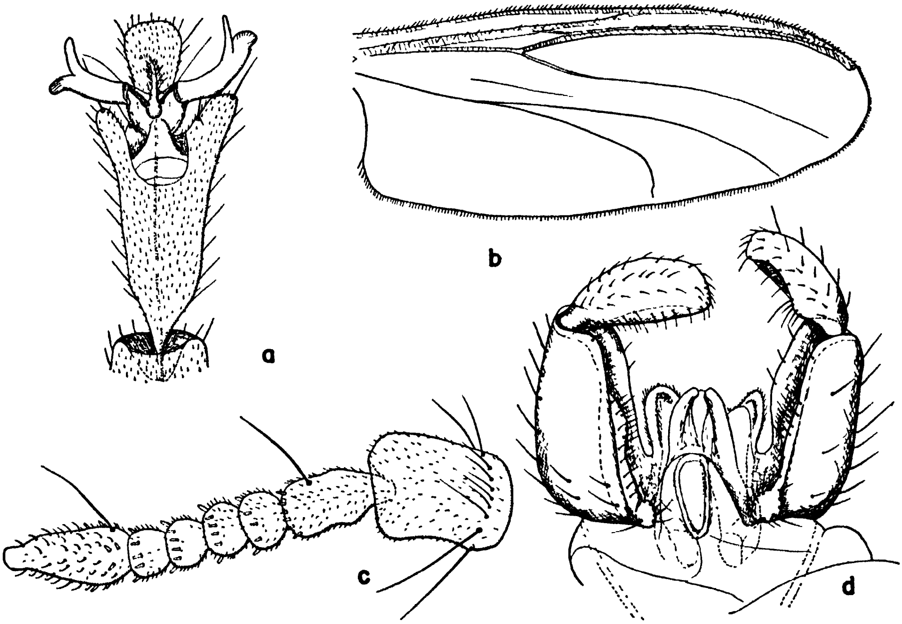

Fig. 6. *Telmatogeton latipennis*. *a*, Left front tarsus of male; *b*, wing; *c*, antenna; *d*, male genitalia, dorsal view.

Pronotal lobes very small and laterally situated, with two or three minute setae. Mesonotum broad and flattened dorsally, overhanging the head anteriorly, the humeral angles broadly rounded and continuing full to wing bases; subdorsal furrows prominent, each with about six or seven long setae, also about four setae above each wing base and two in a median prescutellar group, all these about as long as those on scutellum. Scutellum with ten to twelve setae about as long as length of scutellum.

Wings with venation as in fig. 6, *b*; costa and radius thickened and darkened and bearing numerous fine setae, about thirteen setae on R; thirteen minute setae on R_{4+5}; squamae fringed.

Legs with ratio of segments as follows:

	Cx	Tr	F	Ti	T_1	T_2	T_3	T_4	T_5
Fore leg	30	10	90	90	56	20	11	10	12
Mid leg	20	10	145	110	50	15	10	8	12
Hind leg	30	10	140	105	55	30	10	10	12

Coxae with dense, long setae anteriorly; trochanters simple, with a few setae on outer margin; femora and tibiae slender; front femora short and clavate basally, slender and

unmodified at apex; femora, tibiae, and tarsi with even vestiture of moderate, sharp setae. Fifth tarsal segment (fig. 6, *a*) trilobed, the lateral lobes about half as long as median lobe which is about half as long as proximal portion of segment; claws of all tarsi similar and asymmetrical, bifid at about half the length of claw into a sharp inner arm and a pectinate lateral arm; on the anterior claw the pectinate arm is longer and on the posterior claw the sharp arm is longer.

Abdomen with sparse minute setae, the segments with broad apical whitish bands; ♂ genitalia (fig. 6, *d*) rotated about 90° to the right; basistyle about twice as long as broad, the mesal face at base with a large, rounded, heavily sclerotized, dorsal lobe bearing strong setae, continuing as a sclerotized, dorsomesal, setose margin nearly to apex; an additional low, rounded, setose lobe about midway of mesal margin of basistyle. Dististyles simple and infolded, slightly broader toward the rounded apex with a suggestion of a blunt point; with sparse, fine setae and a small patch of five to ten setae grouped on dorsomesal margin near base. Phallosome with a pair of slender, curved, sclerotized, mesal plates with tips curved dorsad, flanked laterally by a pair of very prominent, sclerotized, pubescent lobes which appear to bear the rather straight, internal parameres, and which may have been formed by a deep cleft from the mesal margin of the basistyle; an indistinct membranous lobe ventral to the mesal plates of phallosome. A prominent, membranous anal lobe protrudes from the eighth dorsum just in front of and partly covering the phallosome.

Length, 2–3 mm.; wing, 1.6–2.2 mm. long by 0.7–0.9 mm. wide.

♀.—Similar to the male, except tarsal claws long, pointed and simple; abdomen extremely pointed apically, the eighth segment laterally compressed about one-fourth as broad and one-half as high as seventh segment, about one-fourth longer than broad at base in side view; cerci very narrow, about two to three times as long as broad and concealing the ovipositor; genital segments bare, with fine pubescence only.

Holotype ♂, allotype ♀.—Socorro Island, Braithwaite Bay, Revillagigedo Islands, May 6, 1925, H. H. Keifer. Paratypes: 9 ♂♀, same data as types; 2 ♂♂, 2 ♀♀, Clarion Island, Revillagigedo Islands, April 28, 1925, H. H. Keifer.

Socorro Island is about two hundred and fifty miles and Clarion Island is about four hundred miles from the west coast of Mexico. *T. latipennis* would fall in the *simplicipes* group in regard to its small size, presence of the sensory setae on the antennae and unmodified mid-trochanters. However, it also shows affinities with the group (*Telmatogeton* s. str. [not *Trissoclunio* as stated in Wirth, 1947*b*, p. 154]) containing the species *sancti-pauli, minor,* and *trochanteratum* in the possession of asymmetrical tarsal claws, position of the cubital fork at level of base of r-m, and the setose dorsal margin of the male basistyles.

7. Genus **Paraclunio** Kieffer, 1911

Paraclunio Kieffer, 1911, Bull. Soc. Hist. Nat. Metz, 27:103; Malloch, 1915, Bull. Ill. St. Lab. Nat. Hist., 10:400; Kieffer, 1919, Bull. Soc. Ent. France, 1919:194; Edwards, 1926, Proc. Zool. Soc. Lond., 51:788; 1928, Konowia, 7:237; 1931, Dipt. Pat. & S. Chile, pt. 2, f. 5, p. 304; Saunders, 1928, Ann. Ent. Soc. Amer., 21:531; Tokunaga, 1933, Philip. Jour. Sci., 51:88.

Genotype: *Paraclunio trilobatus* Kieffer, 1911 (Monobasic).

Diagnostic characters.—Resembling *Telmatogeton*, but differing as follows: Mesonotum, femora, and tibiae with rows of strong bristly hairs (*alaskensis*) or large decumbent scales (*trilobatus*). Front femur of male stout to the tip, on the under side close to the tip with a pair of blunt prominences. Front tibia of male with subbasal prominence which interlocks with those of the femur (from Edwards, 1928). Male genitalia with basistyles bearing a prominent lobe at base of dorsomesal face; phallosome with apices of lateral plates recurved in a prominent anterodorsal hook. Larva and pupa indistinguishable from *Telmatogeton*.

KEY TO THE SPECIES OF PARACLUNIO

Adults

1. Mesonotum, femora, and tibiae with rows of strong bristly hairs; tarsal claws slender, those of ♂ deeply cleft; basal lobe of ♂ basistyle longer than broad; ♀ genital segments longer than high and with very short fine hairs (Alaska to s. Calif.) .... *alaskensis*
Mesonotum, femora, and tibiae with rows of hairs mostly replaced by scales; tarsal claws flattened and broadened, those of ♂ shallowly cleft; basal lobe of ♂ basistyle broader than long; ♀ genital segments short, abruptly tapered posteriorly and bearing tufts of long fine hairs (central California coasts) .... *trilobatus*

Pupae

1. Third abdominal sternite with a prominent median, circular, brown, shagreened patch on anterior margin; terminal disc longer, portion below the suture about 1.5 as long as broad; six to eight hairs on each side of lower margin of disc............... *alaskensis*
Third abdominal sternite without a median shagreened patch; terminal disc shorter, the portion below the suture about 1.1 as long as broad; ten to twelve hairs on each side of lower margin of disc.......... .. .. *trilobatus*

Larvae

1. Labrum with four pairs of large flattened peglike setae on cephalic margin between lateral setal tufts; postclypeus broader than long.......................... *alaskensis*
Labrum with two pairs of large flattened peglike setae on cephalic margin between lateral setal tufts; postclypeus about as broad as long........................... *trilobatus*

Paraclunio trilobatus Kieffer

(Fig. 7)

Paraclunio trilobatus Kieffer, 1911, Bull. Soc. Hist. Nat. Metz, 27:103; Kieffer, 1919, Bull. Soc. Ent. France, 1919:194; Edwards, 1926, Proc. Zool. Soc. Lond., 51:788; 1928, Konowia, 7:234–237; Saunders, 1928, Ann. Ent. Soc. Amer., 21:535.

Paraclunio alaskensis Malloch (in part, not Coquillett, 1900), 1915, Bull. Ill. St. Lab. Nat. Hist., 10:400.

Since an adequate description of this species has not appeared, a redescription is here given:

A very large blackish species characterized by a remarkable flattened scale-like modification of the body hairs in the ♂ and to a slight extent in the ♀; by the flattened and platelike tarsal claws, and the abruptly tapered ♀ genital segments bearing tufts of long fine hairs, and by the broad, rounded, setigerous, basal lobes of the ♂ basistyles.

♂.—Brownish black; head behind eye margin, halteres, and posterior margins of abdominal segments yellowish white; mesonotum, mesosternum, scutellum, and postscutellum a darker pollenose blackish; wings dark, smoky brownish.

Head (fig. 7, *a*) rounded; vertex somewhat excavated mesad and extending forward between the eyes to bases of antennae, bare; a prominent row of long, black bristles over and behind eyes, curving down over the eyes; clypeus prominent and convex with dense, strong setae. Antennae (fig. 7, *d*) seven-segmented, the basal segment large and subcylindrical, about as broad as long, covered with many long setae, the distal segments about half as broad; second segment about twice as long as broad at apex, constricted in middle and crooked and tapered toward base; segments three to six subspherical and subequal, the seventh segment slightly enlarged and distinctly tapering toward apex, about twice as long as broad; last six segments bare except for three setae around basal portion of seventh, and with numerous sensory pits. Ratio of antennal segments 25:22:10:10:10:10:30. Palpi

two-segmented, the segments subequal in length but distal segment much narrower than basal; both with sparse fine setae. Paraglossae large and subovoid, with a few distal setae.

Pronotal lobes small, each with two to four moderate setae. Mesonotum large, the humeri angularly truncated with prominent posthumeral depressions; subdorsal furrows each with eight to ten prominent flattened setae, broadened and deepened caudad and forming a pair of marked prescutellar troughs; two to four flattened setae on median carina in front of scutellum and about four to seven in supra-alar groups. Scutellum with twenty to twenty-five setae with flattened bases and fine, hairlike tips.

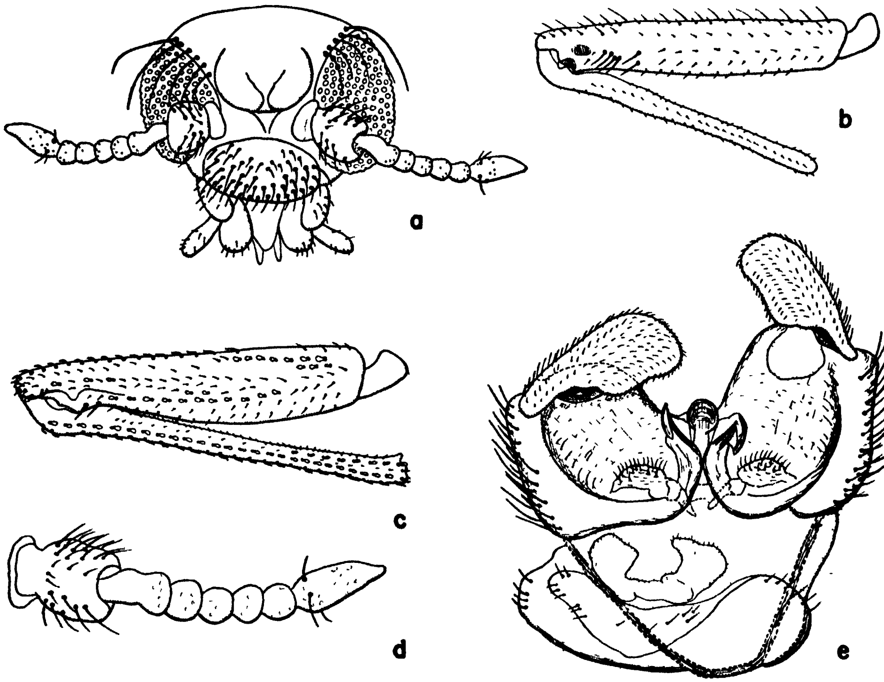

Fig. 7. *Paraclunio trilobatus, a, c–e; P. alaskensis, b. a,* Head, anterior view; *b, c,* right front femur and tibia; *d,* antenna; *e,* male genitalia, dorsal view.

Wings broad at base, distinctly tapered distally; setae on costa and radial branches very fine, about twenty on R, eight on R_1, and about twenty on R_{4+5}; cubital fork very narrow at base, occurring at level of base of r-m Cu_2 gently curved to wing margin; squama fringed.

Legs long, ratio of segments as follows:

	Cx	Tr	F	Ti	T_1	T_2	T_3	T_4	T_5
Fore leg	35	10	93	100	65	25	11	10	18
Mid leg	30	12	160	140	50	18	10	10	17
Hind leg	40	12	155	155	65	32	12	10	15

Coxae large, the anteroventral margins with dense vestiture of long and somewhat flattened setae; trochanters with dense, fine, appressed, flattened setae on ventral face. Remainder of legs clothed partially with broad flattened scales and partially with short stout setae, in longitudinal rows; in some individuals the vestiture of legs nearly all of broad scales, while in others the setae predominating. Front femora (fig. 7, *c*) very broad and modified and apex with an angular projection which fits into a corresponding notch or crook in the base of tibia, the femur with several heavy spines on inner side of the projection. Distal tarsal segments progressively shorter, ventrally flattened and apically lobate; fifth segment very deeply trilobed, the median lobe fingerlike, nearly twice as long as lateral lobes and

as long as undivided portion of segment; empodium large and densely plumose; tarsal claws asymmetrical and unevenly bifid, each claw with a long, sharp, inner arm and a shorter, pectinate, lateral arm which is flattened proximolaterad throughout its length in a thin, vanelike, rounded lobe; a more hyaline lamella representing the pulvillus arising on basal portion of mesal side of claw.

Abdomen with dense vestiture of fine setae arising from light-colored, ocellate spots. Male genitalia (fig. 2, *e*) turned through about 100° to left or right; basistyles about as broad as long, with dorsomesal face flattened and bearing a prominent, rounded, wrinkled, setose, flattened lobe; outer side with dense long bristles; inner face bare except for a few small setae near dorsal margin. Dististyles infolded, narrow at base, distal two-thirds broadly expanded and flattened, with dense, fine setulae. Phallosome a lateral pair of heavily sclerotized, slender, dorsoposteriorly projecting plates with rounded, hooklike, anteriorly recurved apices flanking a mesal, cylindrical, sclerotized penis sheath with anterodorsal margin incomplete; sheath about as long as lateral plates. The lateral phallosomal plates continuous proximad and fusing into the proximodorsal margin of basistyles and articulating at base of free portion with base of a ventrally projecting, heavily sclerotized, rodlike, internal paramere which appears to form an articulating union between the basal lobe of basistyle and the lateral phallosomal plates. A membranous, pubescent, anal lobe on eighth dorsum anterior to base of phallosome.

Length, 5–7 mm.; wing, 6 mm. long by 1.0 mm. wide.

Larva.—Length, mature, about 11 mm., head capsule 1.0 mm. long by 0.75 mm. wide. Color, olivaceous green; head capsule brown; cervical border, mentum, mandibular teeth, and hooks of posterior pseudopods black.

Head oval, slightly tapering to anterior and dorsoventrally flattened; in profile with dorsal margin strongly curved; ventral margin behind mouthparts straight. Frons shield-shaped, half as broad as head at middle, curved to a blunt point at junction of arms of epicranial suture; curving anteriorly to base of clypeus which it touches in a transverse suture about half as long as greatest width of frons; two pairs of minute hairs on lateral margins of frons, the first near anterior corner and the second about two-fifths way back; a pair of setaless tubercles just laterad of suture opposite second frontal hair; a second pair of tubercles bearing a minute hair just laterad of suture behind broadest portion of frons; a pair of long hairs on extreme lateral margin of head just below eye-spot; a lateral pair of setaless tubercles about halfway between these and cervical margin of head, and two dorsal pairs of tubercles halfway to midline near cervical margin. A long hair borne on a large tubercle just laterad of each end of frontoclypeal suture. Antennae borne laterally at level of frontoclypeal suture, short and four-segmented; stout basal segment about half again as long as broad, bearing a peglike second and two minute distal segments and a membranous, biramous Lauterborn's organ adjacent to and as long as these. A small, black, irregular eyespot behind base of mandibles. Postclypeus about as wide as long, preclypeus minute and semicircular. Labrum transverse cephalad in dorsal view, the cephalic (labraliae) and especially the lateral margins (tormae) heavily sclerotized, the intervening membranous area heavily shagreened and bearing two sublateral pairs of long hairs from prominent tubercles. Cephalic margin of labrum sloping downward and curved under in an overhanging "upper lip," the ventral margin of which is produced in three rounded, flattened lobes, the median lobe about three times as long as the lateral pair. Membrane of the anterior or dorsal surface of labrum coarsely reticulate, bearing a dense patch or brush of flattened setae on each lateral margin, with four large, very stout, peglike setae in a dorsally arched mesal row, with a pair of fine, submedian setae and two sublateral pairs of sensory tubercles above these. Ventral side of labrum with a median V-shaped epipharyngeal sclerotization with the cephalic side covered with a membrane densely provided with flattened, pectinately branched setae. Premandibles appearing in anterior view to articulate proximolaterad with the tormae and mesad with the epipharyngeal sclerotization, the premandibles very short and broad, their apices flattened and curved mesad with three, blunt, distal teeth; a membranous fold or sheet about as long as premandible with a sharply serrate fringe arising from its base on mesal side. Mandible heavy and stout, with five blunt, distal teeth, a long, hyaline seta arising near their base and appressed to them; a

brustia of several long, fine hairs on inner side and two long setae on outer margin. Maxilla membranous, at base with a subquadrate lateral sclerite with two long setae and an irregular mesal sclerite with a single long seta at mesal apex; distal margin of maxilla membranous with a lateral beard of short, flattened, appressed hairs and a mesal beard of long fine hairs; about midway of distal margin with a short, truncated, conical palpus, its rounded, membranous apex with numerous minute sensillae; two long setae arising just proximad of base of palpus. Mentum heavily sclerotized and triangular distad, with thirteen teeth, the median tooth broad, with sharp, triangular apex. Hypopharynx a membranous lobe supported by two oblique, slender, sclerotized bars between the mesal ends of which is borne the distal portion of lobe with dense, long, flattened and thickened, serrated spines; the proximal portion of lobe forming a finely shagreened curtain between the proximolateral ends of supporting sclerites.

Prothoracic pseudopod shallowly bilobed with dense crown of slender, black hooks distad, these progressively reduced to minute retrorse spines on posterior margin. Thorax and abdomen devoid of setae except for one or two minute black hairs over each imaginal leg bud, a pair near apex of ninth abdominal segment, and a pair on posterior margin and up on lateral side of posterior pseudopods. Anal gills absent. Posterior pseudopods short, crowned by about 20 large curved black hooks.

Pupa.—Length, about 6–7 mm., stout. Cephalothorax, leg and wing cases sclerotized amber-brown. Anterior margin of cephalic lobe bilobed, a long hair arising on dorsum just mesad of base of each antenna. Thorax arched anterodorsally; with marked transverse, irregular, rugose integumental thickenings. A prominent, forward-projecting, wedge-shaped, prothoracic respiratory organ or lobe arising from each humeral corner; lobe slightly less sclerotized than thorax, the spiracle small, opening dorsally at halfway to apex and at about width of spiracle from outer convex margin of lobe. A lateral pair of long black hairs just under lobes, a sublateral pair between their bases, and a submedian and a lateral pair at posterior margin of mesonotum. Preapical abdominal segments unsclerotized except for narrow U-shaped lines bordering anterior and lateral margins of tergites and sternites, narrow bands of fine shagreening on posterior border of transverse line, and a pair of small patches of shagreening at posterior ends of lateral lines.

Terminal abdominal disc about as broad as long, sclerotized amber brown; rim with heavily sclerotized, brown denticles; disc divided at upper (anterior) fourth by a transverse, dorsally arched suture, rim of dorsal sclerite without hairs but dorsal face with four long, dark hairs equally spaced in a transverse line, the lateral pair near lateral margin of sclerite. Denticles of ventroposterior sclerite with numerous, fine, amber-colored hairs except at extreme caudal apex which is smooth and bilobed and bears ventrally a pair of curved, minute spines; face of posterior sclerite with two pairs of long black hairs in a submedian trapezoid, the posterior pair closer together; face of disc with minute pits and on posterior sclerite with scattered low, blunt, brownish spines. Trunk of eighth segment anterior to disc bearing long, dark hairs as follows: a row of four on each side opposite ends of transverse suture of disc, about twelve or thirteen hairs in a scattered patch on ventral side of disc on each side of the genital lobes to near apex of disc.

Material examined.—California: Del Norte County, Smith River, March, 1948, R. Coleman (light trap), 10 ♂♀. San Mateo County, Pescadero Beach, Jan. 3, 1948, W. W. Wirth, 20 ♂♂, 7 ♀♀, larvae, pupae; Moss Beach, Jan. 3, 1948, W. W. Wirth, 1 ♂, 1 ♀. Monterey County, Moss Landing, July 2, 1948, W. W. Wirth (intertidal rocks on jetty), 3 ♂♂; Carmel Beach, Jan. 3, 1948, W. W. Wirth, 4 ♂♂.

Kieffer (1911) in his original description of *P. trilobatus,* stated that it had been collected by Professor Kellogg in California, on the sea coast, where it lived in society of molluscs of the genus *Haliotis*. The present collections were made over a long expanse of the California coast, and it is probable that this species also ranges northward into Oregon. Saunders (1928) did not find this species at Nanaimo, British Columbia, during his extensive studies on marine insects.

Paraclunio alaskensis (Coquillett)

(Fig. 7, *b*)

Telmatogeton alaskensis Coquillett, 1900, Proc. Wash. Acad, Sci., 2:395; Johannsen, 1905, Bull. N. Y. St. Mus., 86:169; Terry, 1913, Proc. Hawn. Ent. Soc., 2:292.

Paraclunio alaskensis, Malloch, 1915, Bull. Ill. St. Lab. Nat. Hist., 10:400 (in part); Edwards, 1928, Konowia, 7:235; Saunders, 1928, Ann. Ent. Soc. Amer., 21:531.

Coquillett described *Telmatogeton alaskensis* from Yakutat, Alaska. Distribution has since been recorded by Johannsen (1905) from Oregon and California, Cole and Lovett (1921) from Oregon, and Saunders (1928) from British Columbia. The writer has examined a large series of specimens of *alaskensis* from California, unless otherwise noted below, collected by himself: Del Norte County, Smith River, March, 1948, R. Coleman (light trap), 6 ♂♀; Mendocino County, Point Cabrillo, Feb. 15, 1948, 16 ♂♂, 12 ♀♀, many larvae, pupae; Sonoma County, Bodega Bay, Feb. 7, 1948, 34 ♂♂, 3 ♀♀; Marin County, Muir Beach, June 29, 1946, E. L. Kessel, 2 ♂♂; San Francisco County, San Francisco, Mar. 26, 1947, E. L. Kessel, 10 ♂♂, 5 ♀♀; San Mateo County, Pebble Beach, Jan. 3, 1948, 26 ♂♂, 3 ♀♀, Moss Beach, Dec. 21, 1947, 1 ♂, 2 ♀♀, 12 larvae, 17 pupae, Dec. 30, 1947, 50 ♂♂, 10 ♀♀; Santa Cruz County, Santa Cruz, Apr. 18, 1948, C. Spitzer, 3 ♂♂, 1 ♀; Monterey County, Moss Landing, July 2, 1948 (intertidal rocks on jetty), 5 ♂♂, Point Lobos, Jan. 4, 1948, 2 ♂♂, 1 ♀, 42 larvae, 4 pupae; San Diego County, San Diego, Feb. 1, 1913, E. P. Van Duzee, 2 ♂♂, 3 ♀♀. Some of the Nanaimo, British Columbia, specimens described by Saunders (1928) were kindly made available for study by Dr. Saunders.

Great variation in size was noted in the material examined. The development of the body hairs was also quite variable. Specimens from the northern end of the range were consistently larger with stronger and spinelike leg hairs. Toward the southern end of the range, at Point Lobos in Monterey County, many specimens were smaller with weaker leg hairs. The San Diego specimens were all very small. No other characters were found by which the larger specimens differed from the smaller ones, and specifically distinctive structures such as the basal lobe of the basistyle and the shape of the tarsal claws did not vary in the series. Possibly near the southern limits of the range of this species, environmental conditions are adverse enough to result in stunted individuals such as Saunders (1928) found in the summer in British Columbia.

8. Genus **Psammathiomyia** Deby, 1889

Psammathiomyia Deby, 1889, Jour. Roy. Microsp. Soc. Lond., 9:180; Kieffer, 1906, Gen. Ins., 42:6; Edwards, 1926, Proc. Zool. Soc. Lond., 51:788; 1928, Konowia, 7:237; 1929, Trans. R. Ent. Soc. Lond., 77:371; Goetghebuer, 1932, Fauna de France, 23:144.

Genotype: *Psammathiomyia pectinata* Deby, 1889 (monotypic).

Only one species is known, found on the coasts of England and France. Brown (1927) has recently published a short but excellent account of its habits.

9. Genus **Halirytus** Eaton, 1875

Halirytus Eaton, 1875, Ent. Mo. Mag., 12:60; Verrall, 1879, Trans. R. Soc., 168:246; Kieffer, 1906, Gen. Ins., 42:6; Enderlein, 1909, Deutsche Sud-Polar Exped. (1901–1903), Band 10:438; Edwards, 1926, Proc. Zool. Soc. Lond. 51:788; 1928, Konowia, 7:236.

Jacobsiella Rubsaamen, 1906, in Severin, Exped. Antarct. Belge Rap. Scient. Zool. Ins., 8:83; Edwards, 1926, Proc. Zool. Soc. Lond., 51:788.

Genotype: *Halirytus amphibius* Eaton, 1875 (monobasic).

Genotype of synonym: *Belgica magellanica* Jacobs, 1900 (*Jacobsiella;* monobasic).

Two subantarctic species are included in the genus. *H. amphibius* was described from the female by Eaton in 1875, from Kerguelan Island; this species has the antennae five- to six-segmented, palpi, one- or two-segmented, fifth tarsal segment trilobed, tibiae without spurs or comb, the wings rudimentary, halteres small, ovipositor long and pointed. The second species, *H. magellanica* from the Straits of Magellan, Chile, was described by Jacobs (1900) as a *Belgica,* but Rubsaamen erected a new genus, *Jacobsiella,* for it in 1906. Edwards (1928) synonymized *Jacobsiella* with *Halirytus* and believed it possible with study of more complete material that *magellanica* might prove to be the same as *amphibius.* Enderlein (1909) recorded additional material of *H. amphibius* from Kerguelen Island, and gave a very brief description of the larva and egg stages, from material collected on the "Deutsche Sud-Polar Expedition" in 1901–1903. Keilin (1913) explained the fact that the French expedition of the Pourquoi Pas collected many *Belgica,* but no *Halirytus,* with the statement that the former is truly antarctic in its distribution, while the latter belongs to the subantarctic region.

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A SUBGENERIC CLASSIFICATION OF THE NEW WORLD BEES OF THE GENUS ANDRENA

BY

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CONTENTS

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INTRODUCTION

THE SUBGENERIC classification of the New World *Andrena* presented herein is at best only an outline sketch of the systematics of the genus. However, it is hoped that the subject has been given sufficient organization to pose individual problems of classification so that they can be recognized as problems and given the attention and analysis required.

The present classification divides the genus *Andrena*, as represented in the New World, into thirty-one subgenera. A preliminary study of representative species showed that the types of most North American *Andrena* would have to be reëxamined in order to place them in any subgeneric classification based on structural characters. This was accomplished during the summer of 1946, when about 450 holotypes were examined. Since a large number of subgenera have been proposed for the Palearctic *Andrena*, and it was known that some species groups were common to both hemispheres, examples of the type species of all the Old World subgenera were obtained for study. Perhaps 700 or more species, described and undescribed, including many Old World species, have been studied in the course of the present work.

This paper is based upon a thesis presented in partial fulfillment of the requirements for the degree of Doctor of Philosophy, University of California, Berkeley. I am indebted to my wife, Caroline C. Lanham, for assistance in preparing the manuscript for publication.

I am also much indebted to individuals in charge of various important collections, whose unfailing helpfulness has made possible the examination of types and other material. These collections include those of the Illinois Natural History Survey, where the Robertson collection is housed, the United States National Museum, American Museum of Natural History, Academy of Natural Sciences of Philadelphia, Museum of Comparative Zoölogy, University of Nebraska, University of Colorado, Colorado State College (at Ft. Collins), University of California at Berkeley, California Academy of Sciences, and the very rich Timberlake collection at the University of California Citrus Experiment Station, Riverside. I am especially indebted to Mr. P. H. Timberlake, who gave assistance and advice on innumerable occasions and supplied valuable critical notes upon a preliminary manuscript, and to Professors E. G. Linsley and R. L. Usinger for much advice and encouragement. Mr. O. W. Richards of England, the authorities of the British Museum (Natural History), and Mr. P. M. F. Verhoeff of the Netherlands have sent me critical Palearctic species.

HISTORY

The earliest use of a subgeneric classification of *Andrena* was that of Pérez (1890), when, in a list of the bees of southwest Europe, he employed six sub-

generic names, without, however, providing descriptions or designating types. The new names proposed were *Melandrena, Hoplandrena, Chlorandrena, Notandrena, Simandrena,* and *Holandrena.* These names were not used again until Hedicke (1933) designated types and provided descriptions based on his own interpretations of subgenera built up around the type species.

Robertson (1902), in connection with a study of the bee fauna of Carlinville, Illinois, proposed a classification which divided *Andrena* into seven genera. This classification was based on structural characters, and represented a considerable advance in the study of the New World *Andrena.* All the names proposed by Robertson, with the possible exception of *Opandrena,* have been used to a greater or less degree by subsequent writers, usually as subgenera. However, the fact that the classification was based primarily upon the fauna of a small area has limited its applicability to the *Andrena* of the whole of North America. The new generic names established by Robertson in 1902 were *Trachandrena, Iomelissa, Opandrena, Ptilandrena,* and *Pterandrena;* he had proposed *Parandrena* in 1897. In a treatment of the species of the *Andrena* of the northwestern United States and the adjoining region of Canada, Viereck (1904) adopted Robertson's classification.

In 1924, Viereck divided the *Andrena* of the world into twelve subgenera, presenting the diagnoses in a key. He dropped Robertson's *Opandrena* and *Pterandrena,* included *Scrapter* (actually not an andrenine bee), included two subgenera proposed by himself earlier, *Gonandrena* and *Scrapteropsis,* and proposed four new subgenera, *Conandrena, Dactylandrena, Tropandrena,* and *Platandrena.* The subgenera added to the previously existing classification, with the exception of *Platandrena,* contain very few species, and did not much affect the classification of *Andrena* as a whole.

Hedicke (1933) has divided the Palearctic *Andrena* into 22 subgenera, these including the names proposed by Pérez, one of Robertson's (*Trachandrena*), and 13 new subgenera. Each subgenus is briefly characterized, and species known to him to fall within the subgenus are listed. No key is presented. He assigns 278 Palearctic species to subgenera, with an additional 26 species rather doubtfully assigned, there remaining 400 or so unassigned species in the Palearctic fauna, most of which could not be assigned on the basis of published descriptions, and some of which may represent isolated types requiring more subgeneric names.

T. D. A. Cockerell, while never undertaking a subgeneric classification of the *Andrena,* proposed the names *Diandrena, Megandrena,* and *Ancylandrena,* as well as putting into use some of the sounder elements of previously suggested subgeneric classifications. In addition, he did much in the earlier period of the study of North American bees to delimit *Andrena* correctly from its panurgine allies.

MORPHOLOGY

Structural variation within the genus *Andrena* is of a rather subtle type, and has not readily lent itself to use in classification. In a penetrating analysis of the *Andrena* of Scandinavia, Thomson (1872) pointed out many of the significant morphological variations which occur. However, these characters have not been applied consistently by subsequent workers.

HEAD

A characteristic feature of the head of *Andrena* is the pair of facial foveae lying alongside the compound eyes, in the paraocular areas. These are shallow depressions lined with fine, short pubescence, and occur only in females, with the exception that in *A. timberlakei* Cockerell the males have short, pubescent foveae. Males of some other species have depressions near the eyes, but these are not pubescent. Pubescent foveae occur in the females of all *Andrena* and *Megandrena*, and appear to be found nowhere else among the Apoidea. Their very constant occurrence suggests that they have considerable functional significance; Perkins (1919:267) terms them "sensory grooves." Foveae vary in width and length, sometimes being narrow and straplike, and sometimes being so short as to end above the antennal insertions. In most *Trachandrena*, the foveae are unusually deeply impressed and conspicuous; in some other groups, they may be very shallow and rather inconspicuous.

Andrena females have a semicircular row of short setae on the hypostomal carina (which forms the median and posterior boundaries of the cavity of the mandibular insertion), termed by Timberlake (1940:194) the "subgenal coronet." However, this structure is quite poorly developed (or perhaps even absent) in *Callandrena* and in a few *Pterandrena*.

The labrum bears anteriorly a squama, termed the "process of the labrum." This structure is subject to individual variation, but if used with caution it provides a good character. Extreme conditions are represented by a sharply bidentate, reflexed process on the one hand, and a perfectly entire, flat process on the other.

Head shape shows some variation, with extreme conditions being of value in characterizing certain small groups. That part of the head between the compound eyes and the vertex and lower margin of the clypeus is here termed the facial quadrangle (this differs from the original definition of the term given by Cockerell, 1898:171). In a few species, the facial quadrangle is conspicuously longer than wide in the female. Variation in the shape of the facial quadrangle is also of some diagnostic value in males. *Gonandrena* has the cheeks flanged or keeled posteriorly. Females of other *Andrena* show only slight variations in the cheeks, mainly in regard to width. Males show great variation in width and outline of the cheeks, broad cheeks being almost invariably correlated with long mandibles.

The space between the lower end of the compound eye and the mandibular insertion, the malar space, varies in length, but appears to be diagnostic, and then only partially so, of only the subgenus *Dactylandrena*, where it is usually longer than wide. Usually the malar space is so short as to be almost linear, but in some species, especially in *Andrena* s.s., it is of appreciable length.

Mandibles show little variation in the females, although there are a few novelties. In *A.* (*Pterandrena*) *fulvipennis* Smith, there is a conspicuous ventrally projecting process near the base of the mandibles. A few North American species, here placed in *Thysandrena*, have a broad median flange which gives the effect of a third tooth on the inner margin of the mandible. Mandibles are otherwise always bidentate, but females which have done much burrowing

may have the mandibles so worn that they appear to be unidentate. Usually the basal portion of the mandible is furnished with a membranous flange along the posterior margin; this flange shows variation in degree of development, or may be absent. It is possible that the slight variations in the structure of the mandibles of the females may have some value in classification, when carefully analyzed. Males show great variation in the length of the mandibles. When long, the mandibles are usually crossed at the tips (decussate). In some species, especially of *Andrena* s.s., males have a ventrally projecting tooth near the base of the mandible.

Mouthparts are quite variable, but are more often of value in specific rather than subgeneric diagnoses. However, the mouthparts of a subgenus are likely to have a common facies when all species visit a particular type of flower, as in the *Pterandrena* and *Cnemidandrena*, which frequent Compositae. Also, when species are restricted to flowers requiring special adaptations to gather pollen or nectar, novel mouthparts may be found, as in the species of *Iomelissa* and *Scoliandrena*. The basic plan of the mouthparts remains constant throughout the genus, there being always six segments in the maxillary palpus, and four in the labial palpus. Principal variation occurs in the relative lengths of the maxillary and labial palpi. Maxillary palpi are usually moderately reduced in *Pterandrena* and *Cnemidandrena*, and may be almost rudimentary in a few species of other groups. The palpi are greatly elongated in *Iomelissa*, which gathers nectar and pollen from *Viola*, in certain species of *Andrena* s.s., and to a lesser degree in a few species of some other groups. The galea varies in outline, usually being more slender in those species with reduced maxillary palpi. The glossa is unusually long in *Iomelissa*, and in certain species of *Pterandrena*, *Andrena* s.s., and *Dactylandrena*. In those species which collect pollen from *Cryptantha* (and possibly other flowers of similar structure), the mouthparts are furnished with numerous short, hooked setae, as described for *Scoliandrena*. The setae presumably function in lifting the pollen grains out of the flower, the stamens apparently being otherwise inaccessible to the bee. Michener (1944:218) has discussed this situation in *Andrena* and in species of other genera of bees which collect pollen from *Cryptantha*.

In males of many subgenera, the clypeus, and sometimes the lower ends of the paraocular areas, may be brightly colored with some shade of yellow, from chrome yellow to light cream or ivory. This character sometimes shows a degree of individual variation, the clypeus occasionally being entirely black in species normally having the clypeus yellow. Also, stylopized males may have the clypeus abnormally black, or stylopized females may have the clypeus yellow, as in the normal male.

THORAX

Differences in the sculpturing of the thorax (including the propodeum) have long been used in the classification of *Andrena*. The pleura are usually granular in sculpture, but in some groups, e.g. *Trachandrena*, *Mimandrena*, *Schizandrena*, and *Melandrena*, are characteristically roughened, as a result of close punctation, in which case they are termed "coarsely sculptured." The triangular enclosed area of the dorsal surface of the propodeum affords excellent characters, and its sculpture has been used to characterize the large subgenus *Trachandrena*,

where it is coarsely rugulose and transversely carinate at the declivity. Several other subgenera have the enclosure coarsely beaded or wrinkled, but in most *Andrena* it is finely granular over most of the surface. The lateral profile of the propodeum varies between one represented by *Trachandrena,* where it is nearly right-angled, and another represented by *Hesperandrena,* where it is only gently curved. Rarely the dorsal surface of the propodeum outside the enclosure is distinctly punctate; this occurs in *Callandrena,* and in the type species of the Old World *Charitandrena.*

The pollen-collecting apparatus of the propodeum, here given the name "propodeal corbicula" (termed "propodeal basket" by Perkins, 1919:239), has not been used extensively in previous classifications. When best developed, it is a triangular pocket formed by a fringe of long, curled hairs along the anterior margin of the propodeum and another fringe along the lateral margins of the dorsal surface of the propodeum, and opening out below to the area occupied by the hind legs. The interior of this pocket is free of hairs in the most highly developed condition. Such a corbicula, characteristic of *Simandrena, Cnemidandrena,* and some others, is capable of carrying a considerable pollen load. It is noteworthy that the subgenus with the shortest pollen-collecting tibial scopa, *Simandrena,* has the most highly developed propodeal corbicula. The next degree of development is that in which there is a complete fringe of hairs anteriorly (as well as dorsally), but in which the interior is hairy throughout. A fairly common situation is that in which the corbicula is incomplete anteriorly (lacking the fringe of hairs along the anterior margin) and has hairs throughout the interior; this is characteristic of subgenera such as *Trachandrena, Micrandrena, Thysandrena,* etc. There are intermediates between this and the preceding condition. Rather uncommonly, the propodeal corbicula may be rudimentary, the dorsal fringe being nearly or quite absent; the dorsal fringe may be either very short, or the hairs of this region may not be arranged in a compact fringe. Such a condition is characteristic of *Xanthandrena, Dactylandrena, Oligandrena,* and, to a degree, of *Melandrena.* The tibial scopa of such species is always well developed.

The pollen-collecting apparatus of the hind tibiae shows considerable variation, which is of significance at the subgeneric and species-group levels. Further study of the tibial scopa, with standardization of terminology for the different types, is desirable. Robertson (1902) used the presence or absence of branched hairs on the outer face of the tibial scopa as a major character in his classification. In part because the character usually requires high magnification to be seen, in part because there are intermediate conditions in which the hairs may have very short branches, and in part because branched scopal hairs appear independently in numerous species in groups other than those which Robertson characterized as having such scopa, the character has not been used much by subsequent workers. However, it is a very important character when used in combination with others. Some subgenera have the tibial scopa characteristically very short, for example *Simandrena, Scaphandrena,* and many *Andrena* s.s. A good index of the length of the tibial scopa may be obtained by comparing the length of the hairs along the posterior margin of the tibia with the width of the tibia near its apex. In normally long scopae the length is about

equal to the width of the tibia; in the short scopae the length may be one-half or less of the width of the tibia. Species which collect very large pollen grains often have the tibial scopa made up of coarse, sparse bristles; small species groups with such a scopa occur in a few subgenera. There is considerable variation in the degree of compactness of the scopal brush, some subgenera being characterized by a very loose brush composed of erect or suberect hairs. The hind femora have long, branched hairs to which pollen grains may cling, but they do not appear to show any significant variations in arrangement or structure. The brush of hairs on the hind trochanter (trochanteral floccus) is a pollen-collecting structure very characteristic of *Andrena*, and shows variations which are often of importance in classification. When all the hairs on the ventral margin of the trochanter are long and curled, and are incorporated in the brush, the trochanter is said to be "perfect." When, on the other hand, the hairs of the basal half of the trochanter are conspicuously shorter than the rest, nearly straight, and are not incorporated into the brush, the floccus is said to be "imperfect." The floccus may be either dense or sparse; the hairs are invariably branched.

A character used here for the first time is the basal widening and curvature of the posterior spur of the hind tibia in certain groups. This important character was called to my attention almost simultaneously by O. W. Richards, of England, and P. H. Timberlake. In the New World, it occurs in *Schizandrena* and *Aporandrena;* it also occurs in several groups of Old World *Andrena.*

The middle basitarsus is sometimes conspicuously widened in the middle, this is characteristic especially of *Pterandrena*, but is found elsewhere.

The venation of the forewings provides useful characters, but must be used with great caution, since, above all other structural features, it is subject to individual variation. Three New World subgenera, *Callandrena*, *Diandrena*, and *Paranderna*, as well as *Biareolina* of the Old World, are characterized by having two instead of the usual three submarginal cells. Individuals of the normally three-celled species, however, very rarely have only two submarginal cells in one or both wings, as a result of mutation or developmental abnormality, and are then indistinguishable venationally from the two-celled species. An isolated specimen with two submarginal cells, which does not have the facies of one of the subgenera mentioned above, may be suspected of being abnormal. In certain subgenera, notably *Andrena* s.s., the first recurrent nervure ends at about three-fourths of the distance towards the end of the second submarginal cell, whereas in most species the recurrent nervure ends near the middle of the cell. This character is especially subject to individual variation. Usually the basal nervure nearly or quite meets the nervulus, but in some species groups or subgenera it falls conspicuously distad of the nervulus. More rarely, the basal nervure falls distinctly basad of the nervulus. The pterostigma varies in width, sometimes being hardly wider than the prestigma, and sometimes equaling in width the submarginal cells. The width of the pterostigma is usually rather constant in species groups. No characters have been discovered in the hind wings of the North American *Andrena*, but Thomson (1872:72) has pointed out the unusually short jugal lobe in *A.* (*Charitandrena*) *hattorfiana* Fabricius, of Europe.

Abdomen

A conspicuous feature of the dorsal surface of the abdomen is the presence or absence of light-colored hair bands. Although there are intermediate conditions, and racial variation in this respect within species, it is a valuable character when used in combination with other characters. The hair bands occur on the posterior margins of the terga, usually only on terga 2–4, more rarely also on 1. They are usually composed of tightly appressed hairs, but are often composed of loose and erect or suberect hairs. In the majority of species, the terga are not distinctly punctate, but a few groups are characterized by punctate terga. The size and distinctness of the depressed marginal area of tergum 2 is of some significance; in *Trachandrena*, in particular, the segment may be strongly impressed one-half or more of its length, while in most other groups it is impressed one-third or less of its total length. While the pygidium of the female shows considerable variation, this appears to be of specific rather than of subgeneric value.

Morice (1899) investigated the male genitalia of the British *Andrena* with the hope of discovering group characters, but was unable to find anything of subgeneric value. Saunders (1882:227) has also remarked on the lack of variation in the male genitalia of *Andrena*. One of the most fundamental characters seems to be the presence or absence of transparent dorso-lateral flanges on the aedeagus; these flanges are correlated with deep excavations in the sides of the aedeagus. There are intermediate conditions, in which the aedeagus is weakly excavated laterally and hardly or not at all flanged. Aside from the presence or absence of dorso-lateral flanges, there is considerable variation in the shape of the aedeagus. The genital capsule shows some variation within a basic plan, and occasionally subgenera may be characterized by the structure of the capsule, but usually the differences are of specific value. The parameres may be broadly expanded at the tips, as in *Trachandrena*, or slender and straplike, as in *Hesperandrena* or *Gymnandrena*, with many intermediate conditions in other subgenera. The parapenial lobes may be strongly produced and acute, as in *Trachandrena*, or lacking altogether, as in *A*. (*Schizandrena*) *crataegi* Robertson, with all intermediate conditions existing. Variations in the shape of the eighth sternite are chiefly of specific value.

BIOLOGY

Comparative studies in the biology of *Andrena* have not advanced to the point where they can be of much assistance in a subgeneric classification. Perhaps the most significant point of departure would be a study of the pollen-collecting habits, but while this has been done more or less intensively in restricted localities in the United States and in Europe, it has not yet been put on such a broad regional and comparative basis as to be of real value in taxonomic and phylogenetic studies. Careful field study is required to establish definitely which plants a species is truly dependent upon; it is not at all easy to distinguish between casual flower visiting and true pollen collecting. It seems likely that the study could be put on a sound basis by identification to genus of the pollen grains making up the pollen load often found on museum specimens. Also, the

relative importance of nectar gathering in the total economy of the bee should be studied. Malyshev (1926:78) observes that in *A. ovina* Klug, the pollen loaf, placed in the bottom of the nest cell, is ringed with liquid honey.

Some species of *Andrena* are known to collect pollen from only one species of flower in a given locality. However, it often happens that only a single species of a genus of flowering plants will be in bloom in the vicinity of the *Andrena* colony at the time the bees emerge, so that the species should not be credited with a high degree of specific selectivity until their flower-visiting habits over a wide area have been studied. Some species do have marked adaptations to flowers of unusual structure, and are undoubtedly of necessity restricted to particular genera of flowers. Of approximately 45 species of *Andrena* whose flower-visiting habits were known to Robertson at Carlinville, Illinois, 25 collected pollen from only one family of plants, 16 were restricted to a single genus, and 8 collected pollen from only one species (Robertson, 1928). One species of *Andrena* was observed to collect pollen from 17 families of plants.

Bischoff (1927:244) states that the nest construction of *Andrena*, as far as known, is quite uniform. The nest is always dug in the ground and consists of a main tunnel with short lateral tunnels leading to the brood cells, which are placed nearly or quite vertically. Usually there are about four cells, but the number may rarely be as high as twelve. Each cell is provisioned with a single mass of pollen and honey, on which an egg is laid. The cells arc apparently lined with a very thin silky coating and are closed with a lid of spirally-arranged earth particles.

There is some variation in the manner in which the tunnel entrance is concealed, if at all, while the female is actively constructing or provisioning the cells. Malyshev (1926) states that the entrance of the burrow of *A. ovina* is blocked by a small heap of sand, which the female readily penetrates without leaving the entrance open. A similar situation exists in *A. erythronii* Robertson. I observed a fairly large colony of this bee nesting in a beaten pathway at Tinley Park, near Chicago, Illinois, where at least some of the burrow entrances were blocked by a conical heap of fine earth particles, into which the female *Andrena* immediately disappeared after alighting. *A. complexa* Viereck and an undescribed Californian species which gathers pollen from *Arctostaphylos* have scattered nests with the burrow entrances concealed under fallen leaves or small twigs. Nielson (1934:428) states that some *Andrena*, especially *A. argentata* Smith, may penetrate a layer up to twenty centimeters in thickness of loose, shifting sand before encountering their burrows, dug in solid earth. *A. rhodotricha* Linsley, nesting in a vertical bank, left the tunnel entrances open (MacSwain, 1945:134, and personal communication).

Perkins (1919:239) observed several pollen-laden individuals of *A. bucephala* Steph. entering a single tunnel opening, indicating a semisocial condition well known in *Halictus*.

As far as known, the larvae mature during the summer and pass the winter, still inside the brood cell, as adults, to emerge in the following spring. However, the life cycle of the groups (*Cnemidandrena, Pterandrena*) in which all or some of the species emerge in the fall has not been studied in North America. The question of double-brooded *Andrena* has been discussed by Linsley (1937).

DISTRIBUTION

The genus *Andrena* is found on all continents except South America and Australia, but is poorly represented in that part of Africa south of the Sahara. Species are found in Cape Province, central India, Burma, and Formosa. *Melittidia*, recorded from the Bismarck Archipelago and Australia, and previously regarded as congeneric with *Andrena*, is probably not an andrenine bee. A species of *Pterandrena*, which has been given a manuscript name by Viereck, occurs in Panama; it represents the southernmost occurrence of the genus in the New World. Although species occur in central and eastern Florida, Graenicher (1930) lists no *Andrena* from Miami, in the southern part of the State. G. W. Bohart and E. R. Ross, collecting for the California Academy of Sciences, found only a single species in the Cape Region of Baja California, the apparently endemic *A.* (*Callandrena*) *manifesta* (Fox), which occurred abundantly. In the New World, the genus occurs at least as far north as southern Alaska and the northern boundary of Alberta. *Andrena* have not been taken in the Aleutians. In the Colorado Rockies, *Andrena* may be found foraging at least as high as 13,000 feet on favorable slopes.

In the equatorial region of Africa, *Andrena* are found in the mountainous areas; they are apparently unable to penetrate the wet tropics. Like the *Colletes*, the *Andrena* of South Africa are closely related to the Palearctic fauna, and are apparently recent immigrants. *Andrena* have not been recorded from Madagascar.

The *Andrena* fauna of western North America is especially diverse; ten of the subgenera are confined to the western half of the continent, while only three are confined to the eastern half. *Melandrena* occurs in western North America and in the Old World. One subgenus, *Taeniandrena*, is common to both the Old World and the eastern half only of the United States, but the species found in America is probably introduced. Of the remaining American subgenera, eight are found in both the Old and New worlds, and eight are restricted to the New World.

The distribution of *Megandrena*, confined to the desert areas of southern California and the adjacent areas of Arizona and Mexico, should be regarded as a relict one if the supposition (discussed in a succeeding section) that it is a primitive, isolated group is correct. The restriction of the most primitive andrenine bee to warm arid regions (BWh climate of Köppen), now of very limited extent in North America, probably has a significant bearing on the early evolutionary history of bees on this continent. While the present dryness of the area is doubtless extreme, the combination of aridity and a comparatively high winter temperature may make the climate of the area comparable to that of areas in which many primitive ground-nesting bees of the middle Tertiary lived.

SYSTEMATIC POSITION OF ANDRENA

According to the latest comprehensive classification of the Apoidea (Michener, 1944), *Andrena* is one of three genera (*Andrena, Megandrena,* and *Ancylandrena*) in the subfamily Andreninae, with this subfamily, the Oxaeinae, and

Panurginae together making up the family Andrenidae. The present classification follows Michener in considering *Callandrena*, *Diandrena*, and *Parandrena* to be subgenera of *Andrena*. *Ancylandrena* is here reduced to subgeneric rank under *Megandrena;* Michener regarded the two as doubtfully distinct genera. The two known genera of the Andreninae may be separated as follows:

FEMALES

Subgenal coronet absent; hind basitarsus short, one-half to two-thirds length of hind tibia, hairs on outer face of basitarsus long, possibly functioning as part of the pollen-collecting brush, some of hairs on posterior margin more than one-half length of basitarsus; hairs on hind trochanter not forming a definitive pollen-collecting brush; forewing with three submarginal cells; pygidium with a strong, wide, rounded median carina, at least basally. . . . . . . *Megandrena* Cockerell 1927:42.

Type: *Andrena enceliae* Cockerell 1927:43. (Monobasic and original designation.)

Subgenal coronet present, except in a very few primitive forms, where it may be poorly developed or perhaps lacking; hind basitarsus at least three-fourths length of tibia, hairs on outer face of basitarsus short, except near base, not forming part of the pollen-collecting brush, hairs on posterior margin much less than one-half length of basitarsus; hairs on hind trochanter nearly always forming a definitive pollen-collecting brush, which is directed laterally from the midline of the insect (this brush occasionally poorly developed or lacking, apparently as a result of secondary reduction); forewing with either two or three submarginal cells; pygidium usually nearly or quite planate, rarely with strong carina basally . . . . *Andrena* Fabricius 1775:376

Type: *Apis helvola* Linnaeus. (By designation of Viereck 1912:613.)

MALES

Base of parameres not conspicuously narrowed, about as wide as basiparameres, parameres not arched about an extensive median excavation . . *Megandrena*

Base of parameres usually conspicuously narrower than tips, always much narrower than basiparameres, parameres arched about an extensive median excavation . . . *Andrena*

Megandrena is a very remarkable primitive andrenine bee, intermediate in many respects between *Andrena* and certain Neotropical and Australian colletid bees. The distribution of the presumed scopal hairs on the outer surface of the hind legs of *Megandrena*, unique for an andrenine bee, is very similar to that of the colletid *Stenotritus* of Australia. *Stenotritus* lacks the well-developed femoral pollen-collecting brush characteristic of the advanced, widespread *Colletes*. Michener (1944:238) points out that *Stenotritus* often has the glossa rounded, rather than emarginate as in other colletids, and that in at least one species there is a small subantennal plate (which he states may or may not be homologous with that of the andrenids), a character found nowhere else among the colletids, but which is diagnostic of the Andrenidae. *Stenotritus*, unlike *Colletes*, and like the andrenids, has a pygidial plate. Other similarities between *Megandrena* and *Stenotritus* lie in the absence of the subgenal coronet, absence of a true trochanteral floccus, and the slender pterostigma. The major difference is in the absence of pubescent facial foveae in *Stenotritus* (other colletids sometimes have nonpubescent foveae). Male genitalia of *Stenotritus* were not available for study, but the genital capsule of *Megandrena* is more like that of *Caupolicana*, a Neotropical colletid, than that of *Andrena*. While the parameres are articulated as a distinct segment in *Colletes*, in some more primitive colletids, such as *Caupolicana*, the parameres are continuous with the basiparameres, as in *Andrena*. In *Andrena*, the basiparameres are much

wider than the bases of the parameres, and the parameres, arising from the lateral edges of the basiparameres, arch so as to nearly meet apically, leaving between them and the basiparameres a large central cavity, often invaded dorsally to some extent by the parapenial lobes, and occupied by the aedeagus. In *Megandrena* and *Caupolicana*, the parameres are basally as wide as the basiparameres, and are not deeply excavated medially, as in *Andrena*. I do not think that the ventral projections of the parameres of *Megandrena enceliae* are homologous with the parameres of *Andrena* as Michener (1944:241) suggests. Comparison with the genitalia of *M.* (*Ancylandrena*) *atopomosa* Cockerell indicates that they are secondary structures.

Perkins (1919:267) interpreted the similarity between the andreno-panurgine group and the primitive colletids and prosopids to mean that the latter were derived from the andrenids, which he thought to represent the most primitive existing bees. Perhaps the Australian and Neotropical colletids are nearest the ancestral type, with the andrenine bees being derived from them.

Yellow face marks in male, and rarely female, *Andrena* have been generally regarded as a primitive character. *Megandrena* also has yellow face marks in the male. Yellow face marks are very characteristic of the Panurginae, but structural features of the panurgines indicate that they cannot be considered to be the primitive members of the family. Yellow face marks are not at all characteristic of the Colletidae, although the Australian *Andrenopsis*, and the male of a species of *Goniocolletes*, also Australian, have such face marks. It seems likely that yellow facial ornamentation was characteristic of the early andrenid stock, from which panurgines evolved in one direction and andrenines in another.

A bee referred to *Andrena* has been found in Baltic (Lower Oligocene) amber, but its true affinities cannot be regarded as finally determined. Several species of supposedly andrenine bees have been described from the Oligocene of Florissant (Cockerell 1906:31, 1909:159, 1914:634). The absence of *Andrena* from South America would seem to indicate that they evolved in the Northern Hemisphere, and had no long history, at any rate, before late Eocene time. It is likely, however, that *Andrena* is at least as old as the Oligocene.

SYSTEMATICS OF ANDRENA

Although the subgeneric keys apply to the entire New World fauna, the lists of species include only those from America north of Mexico.

Eight of the subgenera proposed or defined by Hedicke for the Palearctic *Andrena* can be quite satisfactorily applied to the New World fauna. *Andrenella* Hedicke and *Micrandrena* Ashmead are clearly synonymous; *Micrandrena* has priority. *Platandrena* Viereck is synonymous with the older *Simandrena* Pérez. A study of the type species of all the Old World subgenera disclosed no other obvious synonymies. All the other names proposed by American authors have been retained except *Tropandrena* Viereck and *Scrapteropsis* Viereck.

P. H. Timberlake had described two new Western American subgenera, *Hesperandrena* and *Stenandrena*, in manuscript and kindly allowed me to include his descriptions in the present paper. In addition to these, eight new

subgenera are proposed. Although numerous isolated species or small species groups, especially in the western United States, appear to be of subgeneric rank, it was thought that the establishment of a large number of new subgeneric names for them would be premature. Most of such groups have been provisionally assigned to subgenera. However, a few of the more interesting and striking groups have been given names, although comprising only one or a few species. Perhaps fifty or more subgenera would present a more balanced classification than does the present one.

The keys are more or less artificial, the three subgenera with two submarginal cells, for example, which are keyed out in the first couplet, not being at all closely related. An attempt to approximate a natural arrangement is made in the order in which the subgeneric descriptions are presented, following the keys. The males of many subgenera which are well characterized in the females are indistinguishable as subgenera, and it has not been possible to prepare a satisfactory key for them. Since the subgenera are visualized as representing minor adaptive areas within the very broad adaptive plateau (in the sense of Mayr, 1942:294) presented by the genus *Andrena*, it is not surprising that the males do not faithfully reflect all the differentiation which the females have undergone. The females do all the work of digging nests and collecting pollen and nectar, and although it cannot be conclusively demonstrated at the present time, the principal morphological variations on which the subgenera are based are for the most part believed to be connected with different ways of doing this work. Males are comparatively amorphous precisely because they are not involved in this work. Those variations which do occur in the males are probably mostly connected with flight (differences in shape and sculpture of the propodeum, venation, etc.) and mating (genitalia, mandibles and cheeks, and facial ornamentation). Classification based on these characters coincides to a surprising extent with the subgeneric classification based on females, but there are many instances where considerable divergence in the females has not been followed by divergence in the males.

Of the 645 names (except *nomina nuda*) which have been assigned to the *Andrena* of America north of Mexico, 502 are assigned to subgenera in the present classification, 67 have been provisionally or doubtfully assigned, and 76 remain which cannot be assigned, being imperfectly known.

As far as possible, the question of species synonymy has been avoided. This is done by presenting mere lists of "names applied," which completely serves the purpose of the present classification. The year-page citations with each name, which cite the original description, serve to open up the study to other workers. It should be emphasized that these lists contain only the species described from America north of Mexico.

KEY TO THE SUBGENERA OF NEW WORLD ANDRENA, BASED ON FEMALES

1. Fore wings with two submarginal cells 2
   Fore wings with three submarginal cells 4
2. (1) Portion of propodeum lying outside enclosure distinctly punctate; face with integument yellow in part . . . . (1) *Callandrena*
   Portion of propodeum lying outside enclosure not punctate; face with integument entirely black or metallic blue or green 3

3. (2) Propodeal corbicula with a complete fringe of long, curled, compound hairs anteriorly . . . . (6) *Parandrena*
   Propodeal corbicula without a fringe of long, curled, compound hairs anteriorly (26) *Diandrena*
4. (1) Posterior spur of hind tibia basally strongly bent and abruptly widened; pleura and enclosure of propodeum coarsely sculptured . . . . (5) *Schizandrena*
   Posterior spur of hind tibia basally at most gently curved and nearly or quite linear; if tibial spur rarely as in *Schizandrena*, pleura and enclosure of propodeum finely sculptured 5
5. (4) Enclosure of propodeum coarsely sculptured, with strong, more or less irregular longitudinal rugae; enclosure bounded posteriorly by a transverse carina which, however, is often interrupted by rugae 6
   Enclosure of propodeum usually finely granular or with weak rugae confined to base of enclosure, but if enclosure coarsely sculptured, it is not transversely carinate behind 7
6. (5) Face of propodeal corbicula without compound hairs, covered with simple hairs throughout, second tergum usually depressed more than one-third distance from posterior to anterior margin, fovea usually deeply impressed, often separated from eye by a wide shining space . . . (23) *Trachandrena*
   Face of propodeal corbicula with compound hairs at least anteriorly; second tergum depressed at most one-third of distance from posterior to anterior margin, fovea weakly impressed, not separated from eye by a wide shining space (24) *Mimandrena*
7. (5) First tergum nearly always with a complete hair band (lacking in some small species), complete hair bands on remaining terga, tibial scopa with hairs of outer face simple, process of labrum bidentate, propodeal corbicula with a complete fringe of hair anteriorly, interior of corbiculum free of hairs; late summer or fall species . . . . . (17) *Cnemidandrena*
   First tergum usually lacking complete hair band, but when present, insect without combination of characters listed above 8
8. (7) Species 8 mm. or less in length (a somewhat larger species, provisionally placed here, is unique in having central half or more of clypeus polished and impunctate), first transverse cubital vein usually ending only two or three vein widths distant from pterostigma, tibial scopa with hairs of outer face simple, process of labrum flat and entire, propodeal corbicula nearly always without a fringe of hairs anteriorly . . . (14) *Micrandrena*
   Species usually 9 mm. or more in length, but when rarely smaller, without combination of characters listed above 9
9. (8) Cheeks bordered posteriorly by a more or less distinct flange or keel, mesoscutellum polished, sparsely punctate, enclosure of propodeum rather coarsely wrinkled (15) *Gonandrena*
   Cheeks without a flange or keel posteriorly 10
10. (9) Propodeal corbicula very highly developed, with a compact fringe of hair anteriorly, interior without hair; tibial scopa unusually short, hairs of outer face much less than width of tibia at apex, simple; terga with conspicuous appressed hair bands . . . . (18) *Simandrena*
   Propodeal corbicula usually with hairs on interior, but if as described above, tibial scopa is composed of long or branched hairs, or terga lack hair bands 11
11. (10) Facial quadrangle distinctly longer than wide; pleural hair various shades of fulvous, hair of mesoscutum not unusually short 12
   Facial quadrangle not longer than wide, or if rarely quadrangle is elongate, pleural hairs black, or hair of mesoscutum unusually short and velvety 13
12. (11) Segments of labial and maxillary palpi much elongated, second segment of labial palpus about as long as first; terga punctate . . . . (11) *Iomelissa*
   Segments of labial and maxillary palpi not elongated, second segment of labial palpus much shorter than first; terga impunctate . . . . (10) *Conandrena*

13. (11) Hairs of outer face of tibial scopa conspicuously branched. 14
Hairs of outer face of tibial scopa simple, or occasionally obscurely branched. . . .16

14. (13) Interior of propodeal corbicula free of hairs, anteriorly with a complete fringe of hairs. . . . .(19) *Stenandrena*
Interior of propodeal corbicula hairy throughout. 15

15. (14) Process of labrum bidentate, or if rarely only slightly emarginate, insect 12 mm. or more in length. . . . .(2) *Pterandrena*
Process of labrum entire, or slightly bilobed; species 11 mm. or less in length (22) *Ptilandrena*

16. (13) Terga conspicuously punctate; process of labrum very short, broad, hardly projecting beyond lower margin of clypeus. . . . .(16) *Opandrena*
Terga usually impunctate, but when punctate, process of labrum projecting well beyond lower margin of clypeus. 17

17. (16) At least first tergum with rather abundant long, erect hair, often all terga abundantly hairy; terga nearly always without distinct hair bands; first recurrent nervure meeting second submarginal cell at two-thirds or more of distance towards end of cell; process of labrum more or less bilobed and/or reflexed at tip. 18
Terga without abundant long, erect hair, or if rather hairy, there are more or less conspicuous hair bands, or the first recurrent nervure meets the second submarginal cell near middle of cell. 19

18. (17) Propodeal corbicula not well developed, hairs along dorsal margin long and curled, but not arranged in a compact fringe, interior of corbicula hairy throughout; fovea not extending down as far as lower margin of antennal insertions (8) *Dactylandrena*
Propodeal corbicula well developed, hairs along dorsal margin forming a compact fringe, posterior two-thirds of interior of corbicula usually without hairs; fovea extending at least as far down as lower margin of antennal insertions (9) *Andrena* s.s.

19. (17) Enclosure of propodeal corbicula coarsely sculptured; process of labrum nearly always distinctly emarginate, or if rarely not emarginate, tip reflexed; usually all of pubescence black, but occasionally that of dorsum of thorax light-colored (28) *Melandrena*
Enclosure of propodeum finely sculptured, or if rarely coarsely sculptured, process of labrum flat and nearly or quite entire. 20

20. (19) Propodeal corbicula with a complete, dense fringe of hairs anteriorly, or if rarely fringe not very dense, interior mostly free of hairs; terga with more or less conspicuous hair bands. . . . .(27) *Leucandrena*
Propodeal corbicula without a distinct fringe of hairs anteriorly, or if weakly fringed anteriorly, no trace of hair bands on terga. 21

21. (20) Clypeus with punctures oval. . . . .(21) *Taeniandrena*
Clypeus with punctures, when present, round. 22

22. (21) Terga with more or less conspicuous hair bands; species less than 11 mm. in length. 23
Terga nearly always without trace of hair bands, but if rarely with hair bands, large species (11 mm. or more) with large, flat process of labrum. 27

23. (22) Posterior spur of hind tibia bent and strongly flattened near base. . (4) *Aporandrena*
Posterior spur of hind tibia at most gently curved near base, nearly or quite linear near base. 24

24. (23) Tibial scopa unusually short, with hairs along posterior margin conspicuously shorter than width of tibia near apex. . . . .(3) *Scaphandrena*
Tibial scopa of normal length, hairs along posterior margin about as long as width of tibia near apex. 25

25. (24) Propodeal corbicula not well developed, hairs along dorsal margin not forming a definitive downward-curling fringe; all terga with conspicuous hair bands (25) *Xanthandrena*

Propodeal corbicula with a definitive dorsal fringe, or if corbicula not well developed, and without dorsal fringe, first tergum lacks hair band.............26

26. (25) Propodeum carinate laterally........ . ...(13) *Hesperandrena*

Propodeum not carinate laterally ....(20) *Thysandrena*

27. (22) Tibial scopa unusually short, hairs along posterior margin of tibia much shorter than width of tibia near apex, facial fovea usually narrow, with upper end occupying one-half or less of distance between eye and lateral ocellus..(7)*Elandrena*

Tibial scopa of at least normal length, hairs on posterior margin of tibia about as long as width of tibia near apex.................. 28

28. (27) Propodeal corbicula rudimentary, no dorsal fringe of long, curled hairs (12) *Oligandrena*

Propodeal corbicula with dorsal fringe of long, downward curling hairs . ..29

29. (28) Prementum of labium with apical one-third furnished with numerous stout, hooked setae................. ....(31) *Scoliandrena*

Prementum of labium without hooked setae.. 30

30. (29) Trochanteral floccus imperfect, hairs of basal half of trochanter short and nearly straight.. ....(29) *Gymnandrena*

Trochanteral floccus perfect, hairs of basal half similar to those of rest of trochanter, long and curved.......... ....(30) *Cryptandrena*

PROVISIONAL SUBGENERIC KEY TO MALES OF THE NEW WORLD ANDRENA

1. Forewing with two submarginal cells 2

Forewing with three submarginal cells 4

2. (1) Clypeus metallic blue ....(26) *Diandrena*

Clypeus yellow or white. 3

3. (2) Dorsal surface of propodeum outside enclosure punctate... .(1) *Callandrena*

Dorsal surface of propodeum outside enclosure impunctate (6) *Parandrena*

4. (1) Clypeus at least in part yellow or white 5

Clypeus entirely black or metallic blue or green 15

5. (4) Cheek narrow, about as wide as eye. . . . 6

Cheek broad, conspicuously wider than eye.... . 12

6. (5) Clypeus mainly black, with at most two yellow dots; palpi elongate, segment two of labial palpus about as long as segment one... (11) *Iomelissa* (part)

Clypeus mainly yellow or white; palpi not unusually elongate, segment two of labial palpus much shorter than segment one..... . . 7

7. (6) Aedeagus expanded basally, sides excavated, dorsolateral membranous flanges present. 8

Aedeagus either slender or expanded basally, sides not excavated, dorsolateral membranous flanges absent................. .... .10

8. (7) Posterior spur of hind tibia widened basally by a membranous flange, spur unusually strongly curved.. ....(4) *Aporandrena* (part)

Posterior spur of hind tibia not widened basally, spur nearly straight 9

9. (8) Terga without appressed hair bands ....(7) *Elandrena*

Terga with conspicuous appressed hair bands..(2) *Pterandrena;* (3) *Scaphandrena*

10. (7) Pleura coarsely sculptured .. . .(5) *Schizandrena* (part)

Pleura finely sculptured..... 11

11. (10) First transverse cubital vein ending one to three vein widths distant from pterostigma....... .. ..(14) *Micrandrena* (part)

First transverse cubital vein ending four or more vein widths distant from pterostigma........ ....(13) *Hesperandrena* (part)

12. (5) First transverse cubital vein ending one to three vein widths distant from pterostigma....... ... .(14) *Micrandrena* (part)

First transverse cubital vein ending four or more vein widths distant from pterostigma....... 13

13. (12) Aedeagus without dorsolateral membranous flanges, base no wider than tips of parameral lobes . . . . (12) *Oligandrena* (part)
Aedeagus either with dorsolateral membranous flanges or with base conspicuously wider than tips of parameral lobes 14
14. (13) Tip of eighth sternum acute . . . . (16) *Opandrena*
Tip of eighth sternum truncate or emarginate . . . . (8) *Dactylandrena*
15. (4) Cheek narrow, about as wide as eye 16
Cheek broad, conspicuously wider than eye 23
16. (15) Enclosure of propodeal corbicula transversely carinate at declivity, parapenial lobes strongly produced and acute 17
Enclosure of propodeal corbicula not transversely carinate at declivity, or if rarely transversely carinate, parapenial lobes not at all or weakly produced 18
17. (16) Aedeagus with dorsolateral teeth near base (these hidden under capsule of genitalia) (24) *Mimandrena*
Aedeagus without dorsolateral teeth near base . (23) *Trachandrena* (part)
18. (16) Pleura and enclosure of propodeum coarsely sculptured . . 19
Pleura finely sculptured, enclosure of propodeum usually finely sculptured . . 20
19. (18) Pleura with black hair . (28) *Melandrena*
Pleura with none of hair black . . . . . (5) *Schizandrena* (part)
20. (8) Parapenial lobes extremely long and slender, sinuate, so that capsule is distinctly constricted beyond middle . . . . (13) *Hesperandrena* (part)
Parapenial lobes less long and slender; capsule of genitalia not constricted beyond middle 21
21. (20) First transverse cubital vein ending one to three vein widths distant from pterostigma . . . . (14) *Micrandrena* (part)
First transverse cubital vein ending four or more vein widths distant from pterostigma 22
22. (21) Posterior spur of hind tibia widened basally by a membranous flange, spur unusually strongly curved . . (4) *Aporandrena* (part)
Posterior spur of hind tibia not widened basally, spur nearly straight (11) *Iomelissa* (part); (13) *Hesperandrena* (part); (18) *Simandrena;* (19) *Stenandrena;* (20) *Thysandrena;* (21) *Taeniandrena;* (22) *Ptilandrena* (part); (25) *Xanthandrena;* (27) *Leucandrena* (part); (29) *Gymnandrena* (part)
23. (15) Aedeagus with sides excavated, dorsolateral membranous flanges present . . . 24
Aedeagus with sides not excavated, dorsolateral membranous flanges absent 26
24. (23) Segment 3 of antenna shorter than 4 . (23) *Trachandrena* (part)
Segment 3 of antenna longer than 4 . . 25
25. (24) Cheek bordered posteriorly with a conspicuous keel or flange . . (15) *Gonandrena*
Cheek not bordered posteriorly with a conspicuous keel or flange (9) *Andrena*, s.s.
26. (23) All terga with conspicuous hair bands . . (17) *Cnemidandrena*
Terga without hair bands, or occasionally very weak hair bands present. 27
27. (26) Eyes distinctly converging above . . . . (12) *Oligandrena* (part)
Eyes parallel or slightly diverging above (22) *Ptilandrena* (part); (27) *Leucandrena* (part); (29) *Gymnandrena* (part); (30) *Cryptandrena;* (31) *Scoliandrena*

1. **Callandrena** Cockerell

Callandrena Cockerell 1898:186; Cockerell and Porter 1899:418; Michener 1944:242.

Rather large species; integument black, except lower ends of paraocular areas and at least part of clypeus yellow, and posterior margins of terga sometimes reddish; male with clypeus and lower ends of paraocular areas yellow.

Female.—Facial fovea rather deeply impressed, wide, and short, not reaching lower margins of antennal insertions; segment 3 of antenna about equal to 4 + 5; maxillary palpus extending only slightly beyond tip of galea, not much longer than labial palpus; subgenal coronet poorly developed. Thorax with none of pubescence black; enclosure of propodeum transversely striate, dorsum of propodeum outside the enclosure distinctly punctate; propodeal corbicula rather poorly developed, no fringe of hairs anteriorly, interior with simple

or branched hairs throughout. Tibial scopa long, rather loose, hairs of outer face either simple or branched; trochanteral floccus perfect, scanty; middle basitarsus not widened at middle. Forewing rather strongly darkened apically, two submarginal cells present, pterostigma slender. Terga strongly punctate, with rather weak hair bands.

Male.—Facial quadrangle longer than wide; antennae with segment 3 longer than 4; cheeks punctate, no wider than eye; mandibles short, apposite Genitalia with parapenial lobe moderately to strongly produced, subacute; aedeagus rather slender, sides not excavated.

Type.—*Panurgus manifesta* Fox 1894:113. (Monobasic.)

Members of this subgenus are distinguished from the other forms with two submarginal cells by the punctate propodeum and yellow face marks in the female. The subgenus is closely related to typical *Pterandrena* (*A. accepta* and relatives), as shown by the yellow face marks of the female and the slender pterostigma. The tibial scopa of the type species has simple hairs, but one of the species, *A. verbesinae* Viereck and Cockerell, has branched scopal hairs, again indicating a relationship to *Pterandrena.* The subgenal coronet is very poorly developed. *Callandrena* approaches *Megandrena* in respect to the poor development of the coronet, but certain primitive *Pterandrena*, especially a Viereck manuscript species from the Canal Zone, have the subgenal coronet almost lacking. Typical *Pterandrena*, *Callandrena*, and *Megandrena* have the pterostigma very slender. These relationships indicate *Callandrena* and *Pterandrena* to be among the most primitive *Andrena*.

The subgenus is found in Texas, the southwestern United States, and the Cape region of Baja California.

NAMES APPLIED TO THE NORTH AMERICAN SPECIES OF THE SUBGENUS CALLANDRENA

manifesta (Fox) 1894:113 (Baja California)
pectidis (Cockerell) 1897:148
verbesinae Viereck and Cockerell 1914:1

2. **Pterandrena** Robertson

Pterandrena Robertson 1902:187, 193; Cockerell 1927:43; Timberlake 1938:24.

Medium to large-sized species; integument black or ferruginous, posterior margins of terga sometimes yellowish; males with clypeus yellow or white.

Female.—Facial fovea wide, upper end occupying more than one-half distance between eye and lateral ocellus, often unusually short; segment 3 of antenna longer than 4 + 5, often conspicuously so; process of labrum usually strongly bidentate, rarely broad and only slightly emarginate; galea slender to moderately broad, palpi variable in relative lengths, usually maxillary palpus not extending much beyond tip of galea, sometimes conspicuously shorter than galea, sometimes extending well beyond tip, labial palpus from shorter to actually longer than maxillary palpus; glossa sometimes unusually elongate. Thorax with none of pubescence black; enclosure of propodeum finely sculptured; propodeal corbicula at most moderately well developed, no compact fringe of hairs anteriorly, interior with hairs at least on anterior one-half, sometimes hairy throughout, some or all of hairs may be branched. Tibial scopa compact to rather loose, hairs of outer face nearly always conspicuously branched, sometimes only moderately strongly branched; trochanteral floccus perfect, scanty to well developed; middle basitarsus conspicuously widened at middle, wider than hind basitarsus. Forewing with three submarginal cells, first recurrent nervure meeting second submarginal cell near or somewhat beyond middle; pterostigma usually slender, occasionally broad. Terga usually punctate, occasionally impunctate, posterior margins of terga 1–4 often with more or less conspicuous appressed hair bands, sometimes these absent.

Male.—Facial quadrangle longer than wide; antenna with segment 3 longer than 4, often as long as 4 + 5; cheek usually about as wide as eye, occasionally distinctly wider, always broadly rounded posteriorly; mandibles rather short, apposite. Genitalia variable, parapenial lobes either strongly or weakly produced; aedeagus expanded basally, sides either excavated or not.

Type.—(*Andrena pulchella* Robertson 1891:57) = *Andrena accepta* Viereck 1916:127. (Original designation.)

Pterandrena characteristically collects pollen from the Compositae, and flies both in the spring and the fall. It is recognizable by the branched hairs of the outer face of the well-developed tibial scopa, the generally bidentate process of the labrum, and the hairy interior of the propodeal corbicula.

The group is widely distributed in the New World.

NAMES APPLIED TO NORTH AMERICAN SPECIES OF PTERANDRENA

accepta Viereck 1916:127
aliciae Robertson 1891:57
aliciarum Cockerell 1897:138
ashmeadi Viereck and Cockerell 1914:45
asteris Robertson 1891:56
barberi Cockerell 1898:448
biscutellata Viereck 1917:393
braccata Viereck 1907:284
campbelli Cockerell 1933:153
crawfordi Viereck 1909:143
determinata Viereck 1917:394
fulvipennis Smith 1853:117
gardineri Cockerell 1906:307
graenicheri Cockerell 1902:104
haynesi Viereck and Cockerell 1914:26
helianthi Robertson 1891:55
helianthiformis Viereck and Cockerell 1914:26
lamellicauda Cockerell 1925:629
lauracea Robertson 1897:331
lincolnella Viereck and Cockerell 1914:46
melliventris Cresson 1872:257
nitidior Cockerell 1900:406
pecosana Cockerell 1913:104
permitis Cresson 1872:257
pulchella Robertson 1891:57
radmitricha Viereck and Cockerell 1914:51
reflexa Cresson 1872:256
rudbeckiae Robertson 1891:56
scutellinitens Viereck 1916:573
sitiliae Viereck 1909:144
solidaginis Robertson 1891:55
tonkaworum Viereck 1917:396
townsendi Viereck and Cockerell 1914:49
trevoris Cockerell 1897:306
verecunda Cresson 1872:257

NAME PROVISIONALLY REFERRED TO PTERANDRENA

A. ricardonis Cockerell 1916:272

3. **Scaphandrena** Lanham, new subgenus

Rather small to medium-sized species, integument black or red; males with clypeus yellow or white.

Female.—Facial fovea narrow, upper end occupying less than one-half distance between eye and lateral ocellus; segment 3 of antenna subequal to or longer than 4 + 5; process of labrum usually bidentate, occasionally nearly or quite entire; maxillary palpus extending well beyond tip of galea, longer than or subequal to labial palpus. Thorax with none of pubescence black; enclosure of propodeum usually with moderately coarse sculpturing basally, propodeal corbicula at most moderately well developed, no fringe of hairs anteriorly, interior hairy throughout. Tibial scopa compact, hairs of outer face simple or rarely compound, unusually short, length of hairs on posterior margin of tibia usually much less than width of tibia at apex, rarely subequal to width of tibia, trochanteral floccus perfect, moderately well developed; middle basitarsus widened near middle, width greater than width near apex of hind basitarsus. Forewing with three submarginal cells, first recurrent nervure meeting second submarginal cell near middle of cell. Terga finely punctate, posterior margins of segments 2–4 with conspicuous complete or nearly complete appressed hair bands.

Male.—Facial quadrangle longer than wide; antenna with segment 3 longer than 4; cheek about as wide as eye; mandibles rather short, apposite. Genitalia with parapenial lobes

moderately strongly produced, rounded; aedeagus expanded basally, sides excavated, dorsolateral flanges present.

Type.—Andrena montrosensis Viereck and Cockerell 1914:48.

Scaphandrena is erected to include those species (except *Pterandrena*) with conspicuously banded terga in the females, and with a yellow or white clypeus in the males. The tibial scopa is characteristically short, and the facial fovea are unusually narrow.

The group is widespread in the United States.

NAMES APPLIED TO NORTH AMERICAN SPECIES OF THE SUBGENUS SCAPHANDRENA

arabis Robertson 1897:334
ellisiae Cockerell 1914:9
montrosensis Viereck and Cockerell 1914:48
physariae Cockerell 1933:154
plana Viereck 1904:226
scurra Viereck 1904:226
sieverti Cockerell 1906:436
sieverti opacicauda Cockerell 1936:1
speculifera Cockerell 1929:444

NAMES PROVISIONALLY REFERRED TO SCAPHANDRENA

mackiae Cockerell 1937:3
platyrhina Cockerell 1929:446

A. sphaeralceae Linsley 1939:160 is an isolated species most closely related to *Scaphandrena*, as shown by the yellow clypeus and flanged aedeagus of the male. The terga are red. The female differs from typcial *Scaphandrena* in having the scopa long and the fovea wide; the compound eyes are unusually widened below.

4. **Aporandrena** Lanham, new subgenus

Medium-sized species; integument black; male with clypeus yellow, at least in part.

Female.—Facial fovea wide, upper end occupying more than one-half distance between eye and lateral ocellus; segment 3 of antenna about equal to 4 + 5; maxillary palpus extending well beyond tip of galea, conspicuously longer than labial palpus. Thorax with none of pubescence black; enclosure of propodeum finely sculptured; propodeal corbicula rather poorly developed, no fringe of hairs anteriorly, interior with simple hairs throughout. Tibial scopa compact, rather short, hairs of outer face simple; trochanteral floccus perfect, moderately well developed; middle basitarsus not conspicuously widened at middle, subequal to hind basitarsus in width; posterior spur of hind tibia curved and flattened near base. Forewing with three submarginal cells, first recurrent nervure meeting second submarginal cell near middle of cell. Terga impunctate, posterior margins of terga 2–4 with conspicuous complete or incomplete appressed hair bands.

Male.—Facial quadrangle about as long as wide; antenna with segment 3 longer than 4; cheek as wide as eye; mandibles rather short, apposite. Genitalia with parapenial lobes not at all produced, aedeagus moderately expanded medially, sides excavated.

Type.—Andrena coactipostica Viereck 1917:372.

This subgenus appears to be related to *Scaphandrena*, but the wide facial fovea and the more nearly normal tibial scopa make it difficult to include the single known species in *Scaphandrena*. The basally widened hind tibial spur is found also in *Schizandrena;* the species of that group are much larger and much more coarsely sculptured.

A. coactipostica is known only from the western United States.

5. **Schizandrena** Hedicke

Schizandrena Hedicke 1933:218.

Large species; integument usually red and black, sometimes all black; clypeus either yellow or concolorous with rest of face.

Female.—Facial fovea wide, upper end occupying more than one-half distance between eye and lateral ocellus; antennae with segment 3 longer than or subequal to 4 + 5; process of labrum usually more or less emarginate; maxillary palpus extending well beyond galea, conspicuously longer than labial palpus. Thorax with none of pubescence black; pleura coarsely sculptured; enclosure of propodeum rather coarsely wrinkled, with dimple in basal half, often with a weak transverse carina at declivity; propodeal corbicula at most moderately well developed, no fringe of hairs anteriorly, simple hairs throughout interior. Tibial scopa compact, outer face composed of long simple hairs; trochanteral floccus perfect, moderately to quite well developed; middle basitarsus not conspicuously widened at middle, subequal in width to hind basitarsus; hind tibia with posterior spur abruptly flattened and curved near base. Forewing with three submarginal cells, first recurrent nervure meeting second submarginal cell near or slightly beyond middle. Terga distinctly punctate, posterior margins either with or without hair bands.

Male.—Facial quadrangle slightly broader than long; mandibles apposite, rather short; cheeks no wider than eye; segment 3 of antenna usually longer than 4, but sometimes conspicuously shorter. Genitalia highly diverse, and often aberrant in structure.

Type.—*Andrena aulica* Morawitz 1876. (Original designation.)

The New World species of the *A. prunorum* group are closely related to *A. aulica* (the type of *Schizandrena*), from Turkestan, which bears out the assertion of Cockerell (1929:754) that *prunorum* was actually related to certain *Andrena* in the arid regions of Asia. The group is characterized by the basally expanded and curved posterior spur of the hind tibia, a feature rare in New World *Andrena*, and the coarsely sculptured thorax. *A. crataegi* is a rather anomalous member of the subgenus, especially in regard to the male genitalia, but the genitalia of *A. mellea* Cresson represent a somewhat intermediate condition.

In the New World the group is widespread, but if the atypical *A. crataegi* is excluded, it is a western group.

Names Applied to the North American Species of the Subgenus Schizandrena

argemonis Cockerell 1896:80
arizonensis Viereck and Cockerell 1914:42
casadae Cockerell 1896:83
crataegi Robertson 1893:273
fracta Casad and Cockerell 1896:84
kincaidii Cockerell 1897:351
kincaidii pascoensis Cockerell 1897:305
mellea Cresson 1868:384
prunorum Cockerell 1896:81
prunorum gillettei Cockerell 1898:172
prunorum mariformis Cockerell 1916:46
prunorum pauperatula Cockerell 1938:6
shasta Viereck 1926:402
subcommoda Cockerell 1902:45

Name Provisionally Referred to Schizandrena

vernoni Viereck 1904:221

6. **Parandrena** Robertson

Parandrena Robertson 1897:337, 1900:50, 1902:187; Cockerell 1897:287, 1922:1; Cockerell and Robbins 1910:181; Viereck 1924:21, 22.

Medium-sized species, integument black or ferruginous; males with clypeus yellow or white.

Female.—Facial fovea wide, upper end occupying more than one-half distance between compound eye and lateral ocellus; antenna with segment 3 subequal to 4 + 5; process of labrum rather small, triangular or truncate, not emarginate at tip; maxillary palpus extending well beyond tip of galea, conspicuously longer than labial palpus. Thorax usually with none of pubescence black; enclosure of propodeum finely sculptured, propodeal corbicula well developed, with a complete fringe of hairs anteriorly. Tibial scopa moderately compact, outer

face composed of either simple or branched hairs; trochanteral floccus perfect; middle basitarsus not conspicuously widened at middle, but often wider than hind basitarsus. Forewing with two submarginal cells; pterostigma broad. Terga usually distinctly punctate, posterior margins with weak to distinct hair bands.

Male.—Facial quadrangle conspicuously broader than long; antenna with segment 3 longer than 4; mandibles long; decussate; cheek conspicuously broader than eye. Genitalia with parapenial lobes rather strongly produced, rounded; aedeagus moderately expanded basally, sides not excavated.

Type.—*Panurgus andrenoides* Cresson 1878:62. (By designation of Cockerell 1897:28.)

Among the forms with two submarginal cells, *Parandrena* is to be recognized by the well-developed propodeal corbicula, the nonmetallic integument, and the yellow clypeus of the male. The males do not have the first flagellar segment modified, as do certain atypical *Diandrena* which have the clypeus yellow.

Parandrena is found throughout the United States, but the subgenus is better represented in the Western States.

Names Applied to the North American Species of the Subgenus Parandrena

andrenoides (Cresson) 1878:62
andrenoides bicolor (Robertson) 1898:47 (not Fabricius)
andrenoides clarigastra Viereck 1908:42
concinnula (Cockerell) 1898:189
enocki (Cockerell) 1898:189
garretti Viereck 1924:243
gibberis Viereck 1924:241
mendosa Viereck 1916:588
nevadensis (Cresson) 1879:214
papagorum Viereck and Cockerell 1914:2
triangularis Viereck 1924:243
wellesleyana (Robertson) 1897:337

7. **Elandrena** Lanham, new subgenus

Medium-sized species; integument black or metallic blue; male with clypeus yellow or white.

Female.—Facial fovea usually narrow, upper end usually occupying less than one-half distance between eye and lateral ocellus, occasionally occupying somewhat more than one-half this distance; antenna with segment 3 subequal to 4 + 5; process of labrum rather small, emarginate or entire, tip usually nodose; maxillary palpus extending somewhat beyond tip of galea, labial palpus usually rather long in relation to maxillary palpus, only a little shorter than maxillary palpus. Thorax always with some black pubescence; enclosure of propodeum finely sculptured; propodeal corbicula only moderately well developed, no fringe of hairs anteriorly, interior hairy throughout. Tibial scopa short, hairs along posterior margin less than one-half as long as width of tibia near apex, hairs of outer face simple; trochanteral floccus variable, perfect or imperfect, rather poorly to well developed; middle basitarsus not conspicuously widened at middle, subequal in width to hind basitarsus. Forewing with three submarginal cells, first recurrent nervure ending at or near middle of second submarginal cell. Terga impunctate or finely punctate-tessellate, posterior margins without hair bands.

Male.—Facial quadrangle longer than wide; antenna with segment 3 conspicuously longer than 4; cheek about as wide as eye, widest near upper end of eye; mandibles short to moderately long, apposite or slightly decussate. Genitalia with parapenial lobes moderately or rather weakly produced; aedeagus expanded basally, sides excavated, dorsolateral flanges present.

Type.—*Andrena amplificata* Cockerell 1910:368.

This group is characterized in the female chiefly by the black pleural hair, short tibial scopa, first recurrent nervure meeting second submarginal cell near middle, and absence of tergal hair bands, and in the male, by the yellow clypeus, narrow cheeks, and flanged aedeagus. In North America, it is found from the Rocky Mountains west to the Pacific Coast.

Names Applied to the North American Species of the Subgenus Elandrena

albiculta Viereck 1917:366
amplificata Cockerell 1910:368
bruneri Viereck and Cockerell 1914:15
chapmanae Viereck 1904:223
hicksi Cockerell 1925:628
sladeni Viereck 1924:239
unicula Cockerell 1933:155
viridibasis Cockerell 1929:444
walleyi Cockerell 1932:286
yosemitensis Cockerell 1924:61

8. **Dactylandrena** Viereck

Dactylandrena Viereck 1924:20; Linsley 1938:268, 1939:157.

Medium-sized species; integument black; males with clypeus yellow, at least in part.

Female.—Facial fovea broad or narrow; malar space often unusually elongate, so that it is longer than wide, but sometimes about one-third as long as wide; antenna with segment 3 conspicuously longer than 4 + 5; process of labrum reflexed at tip, either emarginate or entire; maxillary palpus extending slightly or well beyond tip of galea, subequal to labial palpus in length, glossa often rather long, up to one-half length of prementum. Thorax always with black pubescence; enclosure of propodeum finely sculptured; propodeal corbicula poorly developed, no fringe of hairs anteriorly, dorsal fringe not compact, although hairs are long and curled, interior hairy throughout. Tibial scopa long, moderately compact to very loose and coarse, hairs of outer face simple, trochanteral floccus perfect, rather scanty; middle basitarsus not widened at middle, subequal in width to hind basitarsus. Forewing with three submarginal cells, first recurrent nervure meeting second submarginal cell at about three-fourths distance towards end of cell. Terga weakly or distinctly punctate-tessellate, all with rather abundant erect black pubescence, posterior margins without hair bands.

Male.—Facial quadrangle as long as broad or much longer than broad; antenna with segment 3 much longer than 4, subequal to 4 + 5; cheek much wider than eye; mandibles very long, decussate. Genitalia with parapenial lobes strongly produced, rounded or subacute; aedeagus expanded basally, sides excavated, dorsolateral flanges present.

Type.—(*Andrena maura* Viereck 1924:31, male, not female) = *Andrena caliginosa* Viereck 1916:552. (Monobasic and original designation.)

Viereck established the subgenus *Dactylandrena* on the basis of the spinelike process on the anterior trochanter of the male of *Andrena maura* and the elongate malar space of the male and what he thought to be the female of this species. As Linsley (1938:268) has shown, the subgenus cannot be defined on the basis of these characters. It is here redefined to include those species related to *Andrena* s.s. which have the propodeal corbicula poorly developed and in which the males have a yellow clypeus. Most of the described species have all of the pubescence black in the females.

The group is found from the Rocky Mountains westward.

Names Applied to the North American Species of the Subgenus Dactylandrena

berberidis Cockerell 1905:371
caliginosa Viereck 1916:552
leptanthi Cockerell 1904:27
maura Viereck 1924:31
neurona Viereck 1904:222
porterae Cockerell 1900:401
submaura Linsley 1938:269

A. extensa Viereck 1924:240 is structurally like *Dactylandrena* except that the propodeal corbicula is somewhat better developed and the first recurrent nervure meets the second submarginal cell near or before the middle of the cell. The palpi are unusually long, but the species is not an *Iomelissa*. The male must be known before the species can be definitely placed.

9. **Andrena** Fabricius s.s.

Medium-sized to large species; integument usually black, occasionally obscurely metallic blue or green; male with clypeus black.

Female.—Facial fovea wide, upper end occupying much more than one-half distance between eye and lateral ocellus; segment 3 of antenna equal to or longer than 4 + 5; process of labrum nearly always reflexed at tip and bilobed, occasionally emargination weak or lacking; maxillary palpus usually extending well beyond tip of galea and conspicuously exceeding labial palpus in length, but occasionally extending only slightly beyond tip of galea and subequal to labial palpus in length; rarely the galea and segments of the palpi are greatly elongated. Thorax with or without black pubescence; enclosure of propodeum finely sculptured; propodeal corbicula well developed, nearly always with fringe of hairs anteriorly, posterior two-thirds of interior usually free of hairs. Tibial scopa usually compact and short, length of hairs on posterior margin usually conspicuously less than width of tibia at apex, but occasionally scopa long and loose; hairs of outer face simple, trochanteral floccus perfect, well developed; middle basitarsus sometimes slightly widened at middle, but not exceeding hind basitarsus in width. Forewings with three submarginal cells, first recurrent nervure nearly always meeting second submarginal cell at least three-fourths of distance toward end of cell. Terga impunctate or weakly punctate-tessellate, usually all with long, erect hair, occasionally dense enough to obscure integument, but sometimes hair sparse, or limited to first tergum, posterior margins nearly always without appressed hair bands, rarely weak lateral patches of hair present, or pubescence slightly more dense near margins of terga than elsewhere.

Male.—Facial quadrangle broader than long; cheek much broader than eye, often rather sharply angled behind; mandibles long, decussate, sometimes with a ventral projection near base; antenna with segment 3 longer than 4, usually conspicuously so. Genitalia with parapenial lobes strongly produced, tips rounded; aedeagus much expanded basally, sides excavated, dorsolateral transparent flanges present.

Type.—*Apis helvola* Linnaeus 1758. (By designation of Viereck 1912:613.)

The typical subgenus is characterized in the female by the more or less hairy terga which nearly always lack definitive hair bands, the generally reflexed and bilobed process of the labrum, and the narrow second submarginal cell, which receives the recurrent nervure well beyond the middle. The long mandibles, black clypeus, and laterally flanged aedeagus of the males are diagnostic.

The group is widely distributed in both the New and Old World.

Names Applied to the North American Species of the Subgenus Andrena s.s.

advarians Viereck 1904:224
albihirta (Ashmead) 1890:5
albosellata Cockerell 1931:7
asmi Viereck 1904:225
banffensis Viereck 1924:32
bebbiana Viereck and Cockerell 1914:39
bella Viereck 1924:22
birtwelli Cockerell 1901:283
birtwelli subatrata Cockerell 1931:8
buckelli Viereck 1924:22
carrikeri Viereck and Cockerell 1914:14
ceanothifloris Linsley 1938:270
clarkella (Kirby) 1802:130
clypeoporaria Viereck 1904:224
cockerelli Graenicher 1903:163
cristata Viereck 1916:556
delta Viereck 1903:56
didelta Viereck 1908:42
diversicolor Viereck 1924:76
edwardsi Viereck 1916:731
edwiniae Cockerell 1906:310
enigmatica Viereck and Cockerell 1914:33
erecta Viereck 1924:28
excellens Viereck 1924:76
frigida Smith 1853:115
fulvicrista Viereck 1924:30
harveyi Viereck 1904:224
hemileuca Viereck 1904:224
hitei Cockerell 1907:369
idahorum Viereck 1916:732
impuncta Kirby 1837:268
jacobaea Cockerell 1915:267

Names Applied to the North American Species of the Subgenus Andrena s.s. (*Continued*)

laminibucca Viereck and Cockerell 1914:37
lillooetensis Viereck 1924:237
lummiorum Viereck 1916:564
macoupinensis Robertson 1900:48
magnifica Viereck 1924:77
mandibularis Robertson 1892:272
mesoleuca Cockerell 1924:60
milwaukeensis Graenicher 1903:164
moesta Smith 1879:54
monogonoparia Viereck 1916:566
nodosa Viereck 1924:238
paenefulva Viereck and Cockerell 1914:51
pallida Viereck 1924:78
perarmata Cockerell 1898:88
perezana thaspiiformis Viereck 1917:386
pyrrhacita Cockerell 1907:536
pyrrhacita coloradensis Viereck and Cockerell 1914:39
pyrrhacita mosina Cockerell 1908:330
revelstokensis Viereck 1924:239
rhodotricha Linsley 1939:157
ribesina Cockerell 1906:433
ribifloris Viereck and Cockerell 1914:32
rufosignata Cockerell 1902:46
saccata Viereck 1904:224
salicicola Viereck and Cockerell 1914:52
semifulva Viereck 1916:575
singularis Viereck 1924:80
thaspii Graenicher 1903:162
tincta Viereck 1917:387
topazana Cockerell 1906:434
varia Viereck 1924:81
washingtoni Cockerell 1901:284
washingtoni manitouensis Viereck and Cockerell 1914:31

Names Provisionally Assigned to the Subgenus Andrena s.s.

moesticolor Viereck and Cockerell 1914:31
nitidarum Viereck 1924:78
tridens Robertson 1902:192
varians Kirby 1802:117

A. lewisii Cockerell 1906:435 is possibly an *Andrena* s.s. allied to *thaspiiformis* (Viereck) (*perezana thaspiiformis* Viereck), but the male must be known before definite assignment can be made.

10. **Conandrena** Viereck

Conandrena Viereck 1924:20; Linsley 1939:157.

Medium-sized species; integument black; male with clypeus yellow.

Female.—Facial quadrangle conspicuously longer than wide; facial fovea either wide or narrow; antenna with segment 3 about equal to 4 + 5; process of labrum reflexed at tip, emarginate; maxillary palpus extending well beyond tip of galea, conspicuously longer than labial palpus. Thorax with none of pubescence black; enclosure of propodeum finely sculptured, with a few wrinkles near base; propodeal corbicula not well developed, no fringe of hairs anteriorly, interior with sparse branched hairs. Tibial scopa loose, suberect, hairs of outer face simple or branched; trochanteral floccus perfect, moderately well developed; middle basitarsus not conspicuously widened at middle, at most slightly wider than hind basitarsus. Forewing with three submarginal cells, first recurrent nervure meeting second submarginal cell well beyond middle of cell, basal nervure falling somewhat distad of nervulus. Terga finely punctate or punctate-tessellate, posterior margins with or without hair bands.

Male.—Antenna with segment 3 longer than 4; cheek much wider than eye; mandibles long, decussate. Genitalia with parapenial lobes very weakly produced; aedeagus expanded beyond middle, sides excavated.

Type.—*Andrena bradleyi* Viereck 1907:285. (Monobasic and original designation.)

The long facial quadrangle and lack of black thoracic pubescence characterize this subgenus. The few species placed here are quite diverse.

Species assigned to this subgenus have been recorded from the eastern United States, as far west as the Rocky Mountains.

NAMES APPLIED TO THE NORTH AMERICAN SPECIES OF THE SUBGENUS CONANDRENA

angustifrons Cockerell 1933:155
bradleyi Viereck 1907:285
carolina Viereck 1909:126
cheyennorum Viereck and Cockerell 1914:20
saccharina Cockerell and Rohwer 1907:128

11. **Iomelissa** Robertson

Iomelissa Robertson 1900:50, 1902:187, 188; Viereck 1924:21.

Medium-sized species; integument black; male usually with clypeus yellow.

Female.—Facial quadrangle longer than wide; clypeus protuberant; facial fovea wide, upper end occupying more than one-half distance between eye and lateral ocellus; antenna with segment 3 longer than 4 + 5; process of labrum large, truncate or slightly emarginate; mouthparts with palpi and glossa unusually elongated, maxillary and labial palpi subequal in length, nearly as long as prementum, segment 2 of labial palpus about as long as segment 1, glossa nearly as long as prementum. Thorax with none of pubescence black; enclosure of propodeum finely sculptured; propodeal corbicula not strongly developed, no fringe of hairs anteriorly, interior hairy throughout. Tibial scopa loose, hairs of outer face long, simple; trochanteral floccus nearly perfect, rather scanty; middle basitarsus not conspicuously widened at middle, subequal in width to hind basitarsus. Forewing with three submarginal cells, first recurrent nervure meeting second submarginal cell near middle of cell. Terga distinctly punctate, posterior margins of segments 2–4 with complete or incomplete appressed hair bands.

Type.—*Andrena violae* Robertson 1891:53. (Monobasic.)

Iomelissa is easily recognized by the elongate glossa and labial and maxillary palpi, and by the elongate facial quadrangle. The single known species, *A. violae*, collects pollen only from the flowers of *Viola*.

The species is found from Colorado eastward.

12. **Oligandrena** Lanham, new subgenus

Medium to large-sized species; integument black; male with clypeus yellow or black.

Female.—Facial fovea wide, upper end occupying much more than one-half distance between eye and lateral ocellus, lower end unusually broad; antenna with segment 3 longer than 4 + 5; process of labrum entire; maxillary palpus extending somewhat beyond tip of galea, somewhat longer than labial palpus. Thorax with or without black pubescence; enclosure of propodeum finely sculptured; propodeal corbicula rudimentary, no fringe anteriorly, and dorsal fringe very poorly developed, its hairs not long and down-curling, interior of corbiculum hairy throughout. Tibial scopa loose to moderately compact; trochanteral floccus variable, rudimentary to perfect and moderately well developed; middle basitarsus not widened at middle, subequal in width to hind basitarsus. Forewing with three submarginal cells, first recurrent nervure reaching second submarginal cell from somewhat before to well beyond middle. Terga impunctate or weakly punctate-tessellate, posterior margins without hair bands.

Male.—Facial quadrangle about as long as wide or wider than long; antenna with segment 3 subequal to or longer than 4; cheek much wider than eye; mandibles very long, but nearly or quite apposite. Genitalia with parapenial lobes weakly produced; aedeagus slender, sides not excavated.

Type.—*Andrena macrocephala* Cockerell 1916:278.

This subgenus contains species with unbanded terga, finely sculptured thorax, and rudimentary propodeal corbicula.

Species are known only from the Rocky Mountains westward.

NAMES APPLIED TO THE NORTH AMERICAN SPECIES OF THE SUBGENUS OLIGANDRENA

irana Cockerell 1929:392
macrocephala Cockerell 1916:278
macrocephala tetleyi Linsley 1938:282
metea Cockerell 1924:350
nigroclypeata Linsley 1939:155
peratra Cockerell 1916:46

A. anisochlora Cockerell 1936:137 and *A. dinognatha* Timberlake 1938:26, names which have been applied to what is probably a single species, represent an anomalous type probably most closely related to *Oligandrena*, differing in having the propodeal corbicula better developed. The process of the labrum is triangular and entire, and the male has a very broad facial quadrangle, yellow face marks, and very long mandibles.

13. **Hesperandrena** Timberlake, new subgenus

Mr. P. H. Timberlake has kindly allowed me to present the following description, taken entirely from his manuscript notes.

"A Pacific Coast group of *Andrena*, confined nearly as far known to California but extending south at least as far as Escondido, Lower California. Head broader than long; facial foveae broad. Mandibles with a rather narrow explanate expansion on lower margin between the base and middle. Tibial scopa weakly plumose. Flocculus of hind trochanter rather short and scanty. Middle basitarsus is wider than hind basitarsus. Propodeum with the dorsal surface broad, gently curved and inclined from base to apex, without definite truncation, the lateral margins distinctly carinate, and convexly arcuate. Floccus of propodeum moderately long, and little curved, the anterior half of the pleuron with scattered long erect hairs. Abdomen fasciate, the pygidium planate. In the male the mandibles are rather short, and not or moderately decussate. Cheeks broad and rounded behind. Propodeum as in the female, except that lateral margins are not carinate. Abdomen usually short and broad. Mediodorsal lobes of stipites more or less obsolete, opposed to each other, and make the posterior dorsal margin of stipites obtusely to acutely angulate in middle. Lateroapical lobes of stipites long, slender, not expanded at apex, and bowed inward before the middle. Sagittae moderately expanded at base, subdepressed, and slender at apex. Face entirely black, or with a large pale-yellow or creamy-white mark on clypeus. Clypeus with a more or less dense beard.

"*Type.—Andrena escondida* Cockerell 1938:146."

The group includes *A. baeriae* Timberlake 1941:194 and several undescribed species.

14. **Micrandrena** Ashmead

Micrandrena Ashmead 1899:89; Cockerell 1909:420, 1932:158, 1936:145, 152.
Andrenella Hedicke 1933:210. (New synonym.)

Small species; integument black, metallic blue or green, or ferruginous; male with clypeus yellow or white, or concolorous with rest of integument of face.

Female.—Facial fovea usually narrow, upper end occupying one-half or less of the distance between eye and lateral ocellus, rarely broader; antenna with segment 3 slightly shorter than or equal to 4 + 5; mouthparts variable, usually maxillary palpus conspicuously longer than labial palpus, but sometimes reduced. Thorax with none of pubescence black; enclosure of propodeum usually rather coarsely beaded for the size of the insect; propodeal corbicula not well developed, no fringe of hair anteriorly, at least posterior one-half of interior with hair. Tibial scopa moderately compact, outer face composed of simple hairs; trochanteral floccus nearly perfect, scanty; middle basitarsus not conspicuously widened at middle, as wide as or more slender than hind basitarsus. Forewing with three submarginal cells, second transverse cubitus nearly always ending unusually close (two or three vein widths) to

pterostigma, pterostigma broad, basal nervure often ending conspicuously distad of nervulus. Terga impunctate, posterior margins with more or less incomplete hair bands.

***Male.*—Head shape variable; mandibles either short or very long and decussate, cheek narrow or much wider than eye; antenna with segment 3 shorter than to longer than 4. Genitalia variable, parapenial lobes either strongly or not at all produced; aedeagus expanded basally or medially, sides not excavated.**

***Type.*—*Micrandrena pacifica* Ashmead 1899:89. (Monobasic and original designation.)**

Micandrena constitutes a rather diverse assemblage of small species which usually have the first transverse cubital vein ending very close to the pterostigma. Other important structural features are the entire process of the labrum and the incomplete propodeal corbicula. One group of *Micrandrena*, comprising *A. vandykei* and its relatives, is characterized by having the first recurrent nervure meeting the second submarginal cell near the end of the cell, and by having the males with broad cheeks, often toothed beneath. Males of typical *Micrandrena* have the cheeks narrow and the mandibles short. *A. timberlakei*, which collects pollen from *Cryptantha*, has the mouthparts furnished with hooked setae, as in *Scoliandrena*.

The subgenus is widespread in North America.

Andrenella, of the Old World, is not distinguishable from typical *Micrandrena*.

Names Applied to North American Species of the Subgenus Micrandrena

candidiformis Viereck and Cockerell 1914:33
catalinica Cockerell 1939:25
chlorogaster Viereck 1904:196
fragariana Graenicher 1904:64
illinoiensis Robertson 1891:54
illinoiensis bicolor Robertson 1898:46
melanochroa Cockerell 1898:89
microchlora Cockerell 1922:265
microchlora subalia Cockerell 1936:143
nigrae Robertson 1905:237
nigritarsis Viereck and Cockerell 1914:53
nitidicornis Cockerell 1936:144
nothoscordi Robertson 1897:331
pacifica (Ashmead) 1899:89
personata Robertson 1897:336
piperi Viereck 1904:196
placitae Cockerell 1903:215
primulifrons Casad 1896:183
salicinella Cockerell 1895:4
salicinellina Viereck and Cockerell 1914:17
salictaria Robertson 1905:236
semotula Cockerell 1936:149
solutula Cockerell 1936:150
subtilicornis Viereck 1926:4
timberlakei Cockerell 1929:300
trapezoidea Viereck 1917:402
vagans Cockerell 1932:157
vandykei Cockerell 1936:151
vegana Viereck and Cockerell 1914:17
ziziae Robertson 1891:55

Names Provisionally Referred to Micrandrena

The following names have been applied to a species or species complex with the central half or more of the clypeus polished and impunctate; these insects are rather large for *Micrandrena*, and the transverse-cubitus does not end unusually close to the pterostigma.

bipunctata Cresson 1872:259
clypeata Smith 1853:115
clypeolata Dalla Torre 1896:113
flavoclypeata Smith 1879:54
miserabilis Cresson 1872:259
pennsylvanicola Viereck 1907:284
pronitens Cockerell 1930:114
scutellaris Robertson 1893:148
scutellata Dalla Torre 1896:151

The following names are also provisionally referred to *Micrandrena*.

abacta Viereck 1917:365
cercocarpi Cockerell 1936:140
chlorinella Viereck 1904:189
neonana Viereck 1917:400
ziziaeformis Cockerell 1908:234

15. **Gonandrena** Viereck

Gonandrena Viereck 1917:390, Cockerell 1932:157, 1936:138; Viereck 1924:20.
Tropandrena Viereck 1924:21; Cockerell 1932:157.

Medium-sized species, integument black; males with clypeus black.

Female.—Facial fovea narrow, upper end occupying less than one-half, or occasionally slightly more than one-half of distance between eye and lateral ocellus; antenna with segment 3 about equal to 4 + 5; cheek bordered posteriorly by a more or less distinct keel or flange; process of labrum reflexed at tip, entire or slightly bilobed; maxillary palpus extending well beyond tip of galea, conspicuously longer than labial palpus. Thorax with none of pubescence black; mesoscutellum highly polished, sparsely punctate; enclosure of propodeum coarsely wrinkled, declivity rounded, not carinate; propodeal corbicula rather poorly developed, no fringe of hairs anteriorly, dorsal one-half of interior covered with sparse, coarse, simple hairs. Tibial scopa long, loose, suberect, hairs of outer face either simple or branched; trochanteral floccus perfect, moderately to very well developed; middle basitarsus not conspicuously widened at middle, subequal to hind basitarsus in width. Forewings with three submarginal cells, first recurrent nervure joining second submarginal cell far beyond middle of cell. Terga shining, punctate, posterior margins with weak, more or less incomplete hair bands, or hair bands lacking.

Male.—Facial quadrangle longer than wide; antenna with segment 3 longer than 4. Genitalia with parapenial lobes strongly produced, aedeagus strongly expanded basally, sides excavated.

Type.—*Andrena persimulata* Viereck 1917:390.

As Cockerell (1932:157) has pointed out, *Tropandrena* cannot be separated from *Gonandrena*. The subgenus as here defined is characterized by the keeled cheeks, narrow fovea, polished mesoscutellum, and coarsely sculptured enclosure of the propodeum.

Species assigned to the subgenus have been recorded from the eastern half of the United States.

Names Applied to the North American Species of the Subgenus Gonandrena

algida Smith 1853:116
barbarica Viereck 1917:369
fragilis Smith 1853:115
integra Smith 1853:114
laticeps Provancher 1888:307
lineata Provancher 1888:309
lucifera Cockerell 1932:155
nigrifrons (Cresson) 1878:62
persimulata Viereck 1917:390
platyparia Robertson 1895:119
provancheri Dalla Torre 1896:147

A. robertsonii Dalla Torre 1896:149 (= *A. serotina* Robertson 1893:148) is intermediate between *Gonandrena* and *Micrandrena;* the cheeks are not carinate, but the coarsely sculptured enclosure of the propodeum and the venation link the species more closely to *Gonandrena.*

16. **Opandrena** Robertson

Opandrena Robertson 1902:187, 188, 193; Cockerell 1909:420, 1927:43, 1929:301.

Medium-sized species; integument black or red; male with clypeus and lateral face marks yellow.

Female.—Facial fovea wide, upper end occupying more than one-half distance between eye and lateral ocellus; antenna with segment 3 slightly longer than 4 + 5; process of labrum very short and broad, tip usually slightly emarginate; maxillary palpus extending well beyond tip of galea, conspicuously longer than labial palpus. Thorax with none of pubescence black, although some may be dark brown; enclosure of propodeum moderately coarsely sculptured; propodeal corbicula moderately well developed, no fringe of hairs anteriorly, simple hairs throughout interior. Tibial scopa moderately compact, hairs of outer face

simple; trochanteral floccus imperfect, moderately widened at middle, subequal to hind basitarsus in width. Forewing with 3 submarginal cells, first recurrent nervure meeting second submarginal cell at or before middle of cell. Terga distinctly punctate, posterior margins usually with more or less complete marginal hair bands.

Male.—Facial quadrangle somewhat longer than wide, or about as long as wide; antenna with segment 3 longer, usually much longer, than 4; cheek much wider than eye; mandibles rather long, decussate. Genitalia with parapenial lobes weakly or not at all produced; aedeagus expanded basally, sides usually entire, sometimes excavated; tip of eighth sternite acute.

Type.—*Andrena cressonii* Robertson 1891:56. (Original designation.)

Opandrena, as here limited to species related to *A. cressonii* Robertson, is characterized by the short process of the labrum and punctate terga of the females. As originally defined by Robertson, it could not be characterized in the female, but included the species, exclusive of *Pterandrena*, in which the males had a yellow or white clypeus.

The names which have been applied may refer to only a single wide-ranging species, *A. cressonii*. A manuscript species from California in the Timberlake collection has the terga partly red, and there is another apparently undescribed species in the southeastern states.

NAMES APPLIED TO THE NORTH AMERICAN SPECIES OF THE SUBGENUS OPANDRENA

bridwelli Cockerell 1899:255
cressonii Robertson 1891:56
cressonii transformans Cockerell 1933:157
dubia Robertson 1902:48
kansensis Cockerell 1899:255
latisigna Viereck and Cockerell 1914:22
trumani Viereck and Cockerell 1914:12

NAME PROVISIONALLY REFERRED TO OPANDRENA

pruniforis Cockerell 1898:147

17. **Cnemidandrena** Hedicke

Cnemidandrena Hedicke 1933:212.

Small to large species, integument black; male with clypeus black; species fly in late summer or fall.

Female.—Facial fovea wide, upper end occupying more than one-half distance between eye and lateral ocellus; segment 3 of antenna equal to or longer than 4 + 5; process of labrum more or less reflexed at tip, bidentate, or at least bilobed; maxillary palpus at most extending only slightly beyond tip of galea, somewhat longer than or subequal to labial palpus. Thorax with none of pubescence black; enclosure of propodeum granular or finely wrinkled; propodeal corbicula well developed, with complete fringe of hairs anteriorly, interior free of hairs. Tibial scopa compact, outer face with simple or obscurely compound hairs; trochanteral floccus perfect; middle basitarsus broadened in middle, usually wider than hind basitarsus. Forewing nearly always with tip strongly darkened; three submarginal cells present, first recurrent nervure meeting second submarginal cell at or somewhat beyond middle of cell; pterostigma slender, especially in the larger species. Terga impunctate or weakly punctate, posterior margins of all terga with conspicuous hair bands, although band of first tergum sometimes lacking in smaller species, bands usually very broad, sometimes nearly obscuring the terga.

Male.—Facial quadrangle about as long as wide; antenna with segment 3 longer than 4; cheek broader than eye; mandibles rather long, decussate. Genitalia with parapenial lobes slightly to moderately produced, aedeagus slender or slightly expanded medially, sides not truly excavated.

Type.—*Melitta nigriceps* Kirby 1802. (Original designation.)

The type species, *A. nigriceps* (Kirby), of the Old World, has the propodeal corbicula a little less well developed than do the American species and some other European species. It is also unusual in the large amount of black pubescence present, some of the pleural hairs being black.

Members of this subgenus are late summer or fall species with the hairs of the outer face of the tibial scopa simple, or rarely obscurely branched. Except for a few species which may have second broods, the only other *Andrena* to be found flying at this time of the year in the United States are the *Pterandrena*, which have the hairs of the tibial scopa conspicuously branched. The bidentate process of the labrum, the usual presence of a hair band on the first tergum, and the well-developed propodeal corbicula are good diagnostic characters. Most species have much of the pubescence yellow, a color not common in *Andrena*.

The group is widely distributed in North America, and occurs in the Old World.

NAMES APPLIED TO THE NORTH AMERICAN SPECIES OF THE SUBGENUS CNEMIDANDRENA

albovirgata Cockerell 1900:403
americana Dalla Torre 1896:102
antonitonis Viereck and Cockerell 1914:56
apacheorum Cockerell 1897:306
autumnalis Viereck and Cockerell 1914:44
beulahensis Viereck 1903:53
canadensis Dalla Torre 1896:107
canadensis oslarella Viereck and Cockerell 1914:28
chromotricha Cockerell 1899:128
citrinihirta Viereck 1917:371
clypeonitens Cockerell 1902:47
colletina Cockerell 1906:454
columbiana Viereck 1917:374
costillensis Viereck and Cockerell 1914:50
costillensis indecisa Cockerell 1937:34
fimbriata Smith 1853:116
hirticincta Provancher 1888:308
hirticincta surda Cockerell 1910:264
mentzeliae Cockerell 1897:307
nubecula Smith 1853:117
nubecula tristicornis Cockerell 1931:22
persimilis Graenicher 1904:66
pertarda Cockerell 1916:156
ramaleyi Cockerell 1931:346
simulata Provancher (not Smith) 1888:313
truncata Viereck 1903:54
xanthigera Cockerell 1900:402

NAMES PROVISIONALLY ASSIGNED TO THE SUBGENUS CNEMIDANDRENA

davidsoni Viereck and Cockerell 1914:52
pacta Viereck 1902:53
segregans Cockerell 1900:404

18. **Simandrena** Pérez

Simandrena Pérez 1890:174, Cockerell 1936:145; Hedicke 1933:218.
Platandrena Viereck 1924:21, 22; Cockerell 1936:145, 152; Linsley 1939:160. (New synonym.)

Small to medium-sized species; integument black; males with clypeus black.

Female.—Facial fovea wide, upper end occupying more than one-half distance between eye and lateral ocellus; segment 3 of antenna slightly shorter than 4 + 5; process of labrum entire or slightly bilobed; maxillary palpus extending well beyond tip of maxilla, conspicuously longer than labial palpus. Thorax with none of pubescence black; enclosure of propodeum rather coarsely beaded to finely granular; propodeal corbicula highly developed, with a long and compact fringe of hairs anteriorly, interior without hairs. Tibial scopa unusually short, hairs of outer face fine, simple, less than width of tibia in length, hairs on posterior margin of tibia conspicuously less than width of tibia near apex; trochanteral floccus perfect, highly developed; hind tibia inflated and strongly widened near apex; middle basi-

tarsus not conspicuously widened at middle, subequal in width to hind basitarsus. Forewing with three submarginal cells, first recurrent nervure meeting second submarginal cell near middle of cell. Terga impunctate or weakly punctate, posterior margins of terga 2–4 with conspicuous complete or incomplete appressed hair bands.

Male.—Facial quadrangle slightly longer than wide; antenna with segment 3 equal to or longer than 4; cheek usually no wider than eye, rarely conspicuously wider than eye; mandibles rather short, apposite. Genitalia with parapenial lobes weakly to rather strongly produced; aedeagus slender, sides not excavated.

Type.—*Andrena propinqua* Schenck 1853. (By designation of Hedicke 1933:218.)

NAMES APPLIED TO THE NORTH AMERICAN SPECIES OF THE SUBGENUS SIMANDRENA

angustitarsata Viereck 1904:196
angustitarsata huardi Viereck 1917:368
friesei Viereck 1916:558
hartfordensis Cockerell 1902:103
hypoleuca Cockerell 1939:25
nasonii Robertson 1895:120
nasonii fulvodorsata Viereck 1917:385
nudiscopa Viereck 1904:228
oniscicolor (Viereck) 1904:228
opacibasis Cockerell 1936:146
opacissima Cockerell 1918:165
opaciventris Cockerell 1916:47
orthocarpi Cockerell 1936:147
pensilis Timberlake 1938:27
runcinatae Cockerell 1906:434
wheeleri Graenicher 1904:65
wheeleri pallidior Cockerell 1938:7

19. **Stenandrena** Timberlake, new subgenus

Mr. P. H. Timberlake has kindly allowed me to present the following description, taken entirely from his manuscript notes.

"Narrow-waisted *Andrena* with plumose tibial scopa. Propodeum compressed, the pleural surface greatly enlarged at expense of the dorsal surface, the two surfaces meeting rather sharply, but the margin not carinate. Dorsal surface having its usual breadth at base but strongly narrowing at apex, above it takes up but little more than one-third of the apical margin of the propodeum between the hind coxae. Dorsum of propodeum rather sharply truncate behind, the truncature necessarily small. Basal area large, triangular, passing over onto the truncation. Floccus of propodeum very long, curled, passing anteriorly down the anterior margin of the pleuron, and thus forming a large pollen-pocket. Surface of pleuron thus enclosed smooth and hairless. Flocculus of hind trochanter rather short and scanty but curled. Facial foveae rather broad, contiguous to eyes. Mid basitarsi moderately expanded. Males very ordinary in appearance, with slender legs and no light face markings.

"*Type.*—*Andrena pallidifovea* (Viereck) 1904:228.

"Except in regard to the tibial scopa it is remarkably similar to *Platandrena* Viereck. The males of the two groups are much alike, without good distinguishing group characters. Even the phallic characters are similar and it is reasonable to suppose that the two groups have sprung from a common ancestral stock."

There are several undescribed species from California. *A. plumifera* Cockerell 1916:293 is a synonym of the type species.

20. **Thysandrena** Lanham, new subgenus

Medium-sized or rather small species; integument metallic blue or green, or black; male with clypeus not yellow or white.

Female.—Facial fovea rather wide, upper end occupying half or more of distance between eye and lateral ocellus; antenna with segment 3 subequal to 4 + 5; process of labrum either emarginate or entire; maxillary palpus extending well beyond tip of galea, conspicuously longer than labial palpus. Thorax usually with none of pubescence black; enclosure of pro-

podeum finely sculptured; propodeal corbicula moderately well or poorly developed, no fringe of hairs anteriorly, occasionally dorsal fringe not definitive, interior hairy throughout unless corbicula poorly developed, in which case it is free of hair. Tibial scopa long, moderately compact or loose, outer face composed of simple hairs, trochanteral floccus nearly perfect to imperfect, weakly to moderately well developed; middle basitarsus not conspicuously widened at middle, but may be somewhat wider than hind basitarsus. Forewing with three submarginal cells, position of first recurrent nervure variable. Terga impunctate, posterior margins of terga 2–4 with more or less complete appressed hair bands.

Male.—Facial quadrangle about as long as wide or somewhat longer than wide; segment 3 of antenna variable, shorter than to longer than 4; cheek at most slightly wider than eye; mandibles rather short, apposite or slightly decussate. Genitalia with parapenial lobes weakly to strongly produced; aedeagus moderately expanded at base or slender, sides not excavated.

Type.—*Andrena candida* Smith 1879:56

Thysandrena includes medium-sized or rather small species, usually with tergal hair bands, and which lack the special features characterizing other groups also possessing tergal hair bands. The tibial scopa is composed of long, simple hairs, the propodeal corbicula is incomplete anteriorly, and the males lack unusual features in either the head structure or the genitalia. The group should probably be divided into at least four subgenera, but needs further analysis before this step is taken. The typical group, a rather large one, related to *A. candida*, is characterized by the bidentate and reflexed process of the labrum. *A. geranii*, an isolated species, has the propodeal corbicula very rudimentary. A western group, consisting of species near *A. chlorura*, is characterized by the entire or weakly emarginate process of the labrum and the hairy terga. Another western group, closely related to the *chlorura* group, has the mandibles weakly tridentate in the female; *A. ceanothina* and *A. cristata* belong here.

Names Applied to North American Species of the Subgenus Thysandrena

ablusula Cockerell 1936:135
adelae Viereck 1922:37
argentiscopa Viereck 1917:368
beckeri Cockerell 1921:211
bisalicis Viereck 1908:42
boharti Linsley 1939:159
brachycarpae Viereck and Cockerell 1914:55
brevipalpis Cockerell 1930:109
campanulae Viereck and Cockerell 1914:38
candida Smith 1879:56
candida tramoserica Viereck 1916:553
ceanothina Cockerell 1936:138
chlorura Cockerell 1916:48
claremonti Viereck 1926:2
clementina Timberlake 1941:193
coloradina Viereck and Cockerell 1914:53
cristata Viereck 1916:556
decussata Viereck 1904:225
discolor Viereck 1916:730
fuscisignata Viereck 1917:379
geranii Robertson 1891:54
knuthiana Cockerell 1901:80
lata Viereck 1922:39
medionitens Cockerell 1902:101
novaeangliae Viereck 1907:283
phocata Cockerell 1910:369
salicis Robertson 1891:53
subcandida Viereck 1904:225
subdistans Viereck 1904:226
subtrita Cockerell 1910:263
synthiridis Cockerell 1906:436
taeniata Viereck 1916:583
trizonata (Ashmead) 1890:6
vierecki Cockerell 1904:26
w-scripta Viereck 1904:226
xanthostigma Viereck 1904:225

A. flexa Malloch 1917:92, known only from the female, is structurally like *Opandrena*, except that the process of the labrum is normal (not excessively short). It is unique among North American *Andrena* in having the posterior spur of the hind tibia strongly sinuate apically. Despite its superficial similarity to *Opandrena*, I think the male will show it to belong near *Cryptandrena* or *Thysandrena*.

21. **Taeniandrena** Hedicke

Taeniandrena Hedicke 1933:219; Cockerell 1936:136.

Since the subgenus is represented in the New World by only a single and presumably introduced species, no attempt will be made to characterize the subgenus. *A. wilkella* (Kirby) 1802:145 is distinguished from other species with conspicuous tergal hair bands by the oval punctures of the clypeus. Malloch (1918:61) has presented evidence for regarding it as an introduction from western Europe or the British Isles. The species has not, to my knowledge, been found west of Illinois, where I collected it at Tinley Park, near Chicago, in the spring of 1946. Robertson, who collected intensively in Southern Illinois many years earlier, did not record the species, so it is possible that *A. wilkella* is still extending its range. *A. winkleyi* Viereck 1907:283 is a synonym.

22. **Ptilandrena** Robertson

Ptilandrena Robertson 1902:187, 192; Timberlake 1938:24, Viereck 1924:21.

Small to medium-sized species; integument black or metallic green or blue; male with clypeus not yellow or white.

Female.—Facial fovea of variable width, either wide or narrow; antenna with segment 3 subequal to or slightly longer than 4 + 5; process of labrum entire or slightly emarginate; maxillary palpus usually extending well beyond tip of galea and conspicuously longer than labial palpus, rarely reduced and shorter than galea. Thorax with none of pubescence black; enclosure of propodeum finely sculptured; propodeal corbicula at most only moderately well developed, without a compact fringe of hairs anteriorly, interior hairy throughout. Tibial scopa rather loose, hairs of outer face conspicuously branched; trochanteral floccus variable, imperfect to perfect; middle basitarsus variable in width, usually slender, but occasionally widened in middle and somewhat wider than hind basitarsus. Forewing with three submarginal cells, position of first recurrent nervure variable, but not ending more than two-thirds of distance toward end of cell. Terga finely punctate or impunctate, posterior margins of terga 2–4 with weak to conspicuous appressed hair bands.

Male.—Facial quadrangle about as long as broad; cheek either wider than eye or about as wide as eye; mandibles long and slightly decussate or short and apposite. Genitalia with parapenial lobes weakly to moderately produced; aedeagus moderately expanded basally or slender, sides not excavated.

Type.—*Andrena erigeniae* Robertson 1891:52. (Original designation.)

Ptilandrena includes a group of small or medium-sized species with branched hairs on the outer face of the tibial scopa, differing from *Pterandrena* by not collecting pollen from the composites, and by appearing only in the spring. Structural features include a rather weakly bilobed or entire process of the labrum and a propodeal corbicula which is hairy throughout.

Names Applied to the North American Species of the Subgenus Ptilandrena

acrypta (Viereck) 1904:229
atala Viereck 1903:55
caerulea territa Cockerell 1898:89
coerulea Smith 1879:55
complexa (Viereck) 1904:228
crypta (Viereck) 1904:228
erigeniae Robertson 1891:52
erigenoides (Viereck) 1904:228
francisca Viereck 1916:595
g. maculati Robertson 1897:333
nubilifascia Viereck 1916:597
pediculihirta Viereck 1916:598
polemonii Robertson 1891:54
polygoni Viereck and Cockerell 1914:18
suavis Timberlake 1938:24
supervirens Cockerell 1924:64
supervirens aurescens Cockerell 1924:64
trivialis Viereck 1917:388

NAME PROVISIONALLY REFERRED TO PTILANDRENA

hirsutula Cockerell 1936:282

A. pallidiscopa (Viereck) 1904:228, *A. p. trifasciata* Timberlake and Cockerell 1933:28, and *A. nudimediocornis* (Viereck) 1904:229 have been applied to a species in which the female is structurally like *Pterandrena* in having the process of the labrum bidentate, but the male does not have yellow face marks, and it is not a visitor of Compositae. It is probably more closely allied to *Ptilandrena* than to *Pterandrena*, but is an anomalous type.

23. **Trachandrena** Robertson

Trachandrena Robertson 1902:187, 189; Cockerell 1929:754.

Scrapteropsis Viereck 1922:42; Cockerell 1929:754; Viereck 1924:21. (New synonym.)

Medium to small-sized species; integument usually black, occasionally more or less red, rarely metallic blue; males with clypeus black.

Female.—Facial fovea wide, upper end occupying more than one-half distance between eye and lateral ocellus, fovea usually deeply impressed, inner margin usually separated from eye by shining space of appreciable width; antenna with segment 3 usually distinctly shorter than 4 + 5; process of labrum moderately large, bilobed, truncate, or rounded, not strongly bidentate; maxillary palpus extending well beyond tip of galea, conspicuously longer than labial palpus. Thorax either with or without black pubescence; pleura coarsely sculptured, enclosure of propodeum nearly always with strong, more or less longitudinal rugae, declivity abrupt, marked by transverse carina; propodeal corbicula not well developed, no fringe of hairs anteriorly, simple hairs throughout interior. Tibial scopa compact, hairs of outer face simple; trochanteral floccus nearly to quite perfect, rather scanty; middle basitarsus not conspicuously widened at middle, subequal in width to hind basitarsus. Forewing with three submarginal cells, first recurrent nervure ending near or distinctly beyond middle of second submarginal cell. Terga nearly always distinctly punctate, shining, posterior margins with or without hair bands; tergum 2 usually depressed more than one-third its width.

Male.—Facial quadrangle usually somewhat longer than wide, occasionally quadrate, antenna with segment 3 nearly always shorter than 4, rarely longer than 4; mandibles nearly always short and apposite, rarely long and decussate; cheeks nearly always no wider than eye, rarely conspicuously wider than eye. Genitalia with parapenial lobes acute, tips of parameres strongly expanded; aedeagus moderately expanded basally, sides excavated or not.

Type.—*Andrena rugosa* Robertson 1891:58. (Original designation.)

This large subgenus is rather easily characterized by the rugose, transversely carinate enclosure of the propodeum and the incomplete propodeal corbicula, with simple hairs throughout the interior of the corbicula. Males are characterized by similar thoracic sculpturing, and by the acute, strongly produced parapenial lobes of the genitalia.

This subgenus has usually been considered to be a strongly differentiated group, and has been considered worthy of generic rank. No characters have been found in this study which give it unusual distinctiveness. However, at least certain western species differ markedly from other *Andrena* in having the thorax very hard, so that they are comparatively difficult to pin, and feel noticeably firmer when picked up while alive. It may be that there are some internal features of the thorax which might serve to mark off *Trachandrena* more distinctively than has been done here.

Species are found throughout North America. The group is apparently more poorly developed in the Old World. *A. neglecta* (Dours), of Europe and North Africa, the type of *Biareolina* Dours (1873:288), is distinguished from *Trachandrena* only by the presence of two submarginal cells.

NAMES APPLIED TO NORTH AMERICAN SPECIES OF THE SUBGENUS TRACHANDRENA

abjuncta Cockerell 1929:445
alamonis Viereck 1916:599
alleghaniensis Viereck 1907:280
amphibola (Viereck) 1904:159
auricauda (Viereck) 1904:161
brevibasis Cockerell 1931:8
ceanothi Viereck 1917:404
cleodora (Viereck) 1904:161
coactifera Viereck 1926:399
corrugata Cockerell 1931:9
crassihirta (Viereck) 1904:160
cupreotincta Cockerell 1901:153
cyanophila Cockerell 1906:431
daecki Viereck 1907:280
davisiana Viereck and Cockerell 1914:6
dolichotricha Cockerell 1924:348
eriogoni Cockerell 1927:397
fenningeri Viereck 1922:42
forbesii Robertson 1891:59
fuscicauda (Viereck) 1904:161
grandior Cockerell 1897:307
hadra Viereck 1904:160
heraclei Robertson 1897:336
hippotes Robertson 1895:120
indianensis Cockerell 1929:757
indotata (Viereck) 1904:160
jockorum Viereck and Cockerell 1914:3
kalmiae Atwood 1934:208
limarea (Viereck) 1904:160
lincolni Viereck and Cockerell 1914:46
lutzi Cockerell 1931:12
mariae Robertson 1891:58
mariae concolor Robertson 1898:46
marioides Viereck 1916:601
martialis Viereck and Cockerell 1914:5
melanodora Cockerell 1932:173
miranda Smith 1879:54
morrisonella Viereck 1914:399
moscovensis Viereck and Cockerell 1914:13
multiplicata Cockerell 1902:46
multiplicatiformis Viereck 1907:284
nortoni Viereck 1916:602
nuda Robertson 1891:57
obscura (Robertson) 1902:189
ochreopleura (Viereck) 1904:160
paenerugosa Viereck 1907:285
perdensa (Viereck) 1904:160
perforatella Cockerell 1906:306
pernuda (Viereck) 1904:161
politissima Cockerell 1918:166
postnitens Cockerell 1931:15
profundiformis Viereck and Cockerell 1914:8
prunicola Cockerell 1913:375
quintiliformis Viereck 1916:606
quintilis Robertson 1898:46
radiatula Cockerell 1902:46
rehni Viereck 1907:284
rodecki Cockerell 1929:755
rugosa Robertson 1891:58
salicifloris Cockerell 1897:351
semipunctata Cockerell 1902:102
seneciophila Cockerell 1928:62
sigmundi Cockerell 1902:45
sphecodina Casad and Cockerell 1896:78
sphecodiniformis Viereck and Cockerell 1914:6
spiraeana Robertson 1895:120
striatifrons Cockerell 1897:308
stricklandi Cockerell 1936:275
submariae Viereck and Cockerell 1914:4
swenki Viereck and Cockerell 1914:3
tacitula Cockerell 1910:262
tacitula grossulariae Viereck and Cockerell 1914:9
titusi Viereck and Cockerell 1914:12
trachandrenoides Viereck 1904:221
veris Cockerell 1933:156
weedi Viereck 1907:284

24. **Mimandrena** Lanham, new subgenus

Medium-sized species; integument black; males with clypeus black.

Female.—Facial fovea wide, upper end occupying more than one-half distance between eye and lateral ocellus; antenna with segment 3 shorter than 4 + 5; process of labrum entire; maxillary palpus extending well beyond tip of galea, conspicuously longer than labial palpus. Thorax with none of pubescence black; pleura coarsely sculptured; enclosure of propodeum with moderately coarse, irregular longitudinal rugae, declivity abrupt, with transverse carina present; propodeal corbicula moderately well developed, no compact fringe of hairs anteriorly, interior hairy throughout, many of hairs of anterior half branched. Tibial scopa compact, outer face composed of simple hairs; trochanteral floccus perfect, moderately well developed; middle basitarsus not conspicuously widened at middle, subequal in width to hind basitarsus. Forewing with three submarginal cells, first recurrent nervure meeting

second submarginal cell well beyond middle. Terga punctate, shining, posterior margins of terga 2–4 with hair bands; tergum 2 depressed about one-third its length.

Male.—Facial quadrangle somewhat longer than broad; antenna with segment 3 of antenna shorter than 4; cheek about as wide as eye; mandibles rather short, apposite. Genitalia with tips of parameres broadly expanded, parapenial lobes strongly produced, acute; aedeagus expanded basally, lateral teeth present basally.

Type.—Andrena imitatrix Cresson 1872:258.

Mimandrena is proposed for *Trachandrena*-like species with branched hairs on the face of the propodeal corbiculum. This is the group to which Viereck may have intended to apply the name *Scrapteropsis*. Sandhouse (1943:599) stated the type of *Scrapteropsis* to be *A. fenningeri* Viereck, for the reason that it was monobasic; however, two supposedly related species, one of them "*A.* (*S.*) *imitatrix* Cresson," are mentioned in the diagnosis. Nevertheless, Sandhouse's designation of the type must stand. Apparently Viereck meant to substitute *Scrapteropsis* for his earlier (1917:398, 399) incorrect use of *Scrapter*, which he applied to *imitatrix* and its relatives. According to Michener (1944: 237), *Scrapter* is not an andrenine bee; Viereck's diagnosis of *Scrapter* given in his 1924 key applies perfectly well to *Biareolina*, an Old World *Trachandrena*-like subgenus of *Andrena* with two submarginal cells. *A. fenningeri*, unfortunately, is a typical *Trachandrena*, as here defined, so that it is necessary to erect a new subgeneric name for the *imitatrix* group. I have seen the manuscript name *Mimandrena*, on what was apparently a Viereck label, on a specimen of *imitatrix*, s. l., and select the name as an appropriate one.

Several names have been applied to *imitatrix*-like species, but it is possible that there is but a single wide-ranging (from the Rocky Mountains eastward) species in the New World.

NAMES APPLIED TO NORTH AMERICAN SPECIES OF THE SUBGENUS MIMANDRENA

albofoveata Graenicher 1903:166
claytoniae Robertson 1891:59
crataegiphila Viereck and Cockerell 1914:7
imitatrix Cresson 1872:258
imitatrix profunda Viereck 1917:398
johnsoniana Cockerell 1906:224
tardula Cockerell 1929:447
texana auct. not Cresson 1872:258

25. **Xanthandrena** Lanham, new subgenus

Medium-sized to large species; integument black, with posterior margins of terga tending to translucent yellow; males with clypeus black.

Female.—Facial fovea of variable width; segment 3 of antenna slightly shorter than 4 + 5; process of labrum bidentate; maxillary palpus extending well beyond tip of galea, conspicuously longer than labial palpus. Thorax with none of pubescence black; enclosure of propodeum finely sculptured; propodeal corbicula poorly developed, no fringe of hairs anteriorly, dorsal fringe not curled downward. Tibial scopa rather loose, hairs of outer face suberect, simple, trochanteral floccus imperfect, poorly developed; middle basitarsus not conspicuously broadened at middle, subequal to hind basitarsus in width. Forewing darkened at least apically, three submarginal cells present, first recurrent nervure meeting second submarginal cell at or slightly before middle of cell. Terga punctate-tessellate, all with conspicuous ferruginous hair bands, terga quite hairy between bands.

Male.—Facial quadrangle slightly longer than broad; antenna with segment 3 slightly longer than 4; cheek subequal to or somewhat wider than eye; mandibles rather short, apposite. Genitalia with parapenial lobes moderately produced, rounded; aedeagus slender or moderately expanded basally, sides not excavated.

Type.—Andrena auricoma Smith 1879:56.

Xanthandrena includes species with bright fulvescent pubescence in which all terga have conspicuous hair bands, the propodeal corbicula is poorly developed, and in which the wings are strongly darkened, at least apically.

The described species have been found only in western North America.

Names Applied to North American Species of the Subgenus Xanthandrena

astragali Viereck and Cockerell 1914:46
auricoma Smith 1879:56
zygadeni Cockerell 1932:174

26. **Diandrena** Cockerell

Diandrena Cockerell 1903:75, 1922:1; Cockerell and Robbins 1910:181, 190; Michener 1944:242.

Small to large species; integument metallic blue or green; male with clypeus concolorous with rest of integument, rarely yellow.

Female.—Facial fovea wide, upper end occupying more than one-half distance between eye and lateral ocellus; antenna with segment 4 subequal to or longer than 4 + 5; maxillary palpus extending well beyond tip of galea, conspicuously longer than labial palpus. Thorax with or without black pubescence; enclosure of propodeum finely sculptured to moderately coarsely beaded; propodeal corbicula at most only moderately well developed, no fringe of hairs anteriorly, interior nearly always hairy throughout. Tibial scopa usually loose, erect or suberect, sparse, hairs of outer face usually simple, sometimes some branched hairs present; trochanteral floccus usually perfect, moderately well developed; middle basitarsus not conspicuously widened at middle, subequal in width with hind basitarsus. Forewings with two submarginal cells, basal nervure usually falling distad of nervulus. Terga usually impunctate, occasionally rather weakly punctate-tessellate, posterior margins usually without conspicuous hair bands.

Male.—Facial quadrangle broader than long; antenna with segment 3 longer than 4; cheek wider than eye; mandibles long, decussate. Genitalia with parapenial lobes strongly produced, acute; aedeagus slender to moderately swollen, sides excavated.

Type.—*Panurgus chalybaeus* Cresson 1878:61. (Original designation.)

Among the forms with two submarginal cells, *Diandrena* is recognized by the propodeal corbicula not having a fringe anteriorly, by the impunctate propodeum, the metallic-colored integument, and by the dark clypeus of the male. *A. atypica* (Cockerell) is an anomalous form with a yellow clypeus in the male and a peculiarly modified eighth sternum; this species is also remarkable in having the inner surface of the first flagellar segment of the male hollowed out in such a manner that the antennae would appear to fit smoothly over the compound eyes. *A. submoesta* (Viereck), otherwise a normal *Diandrena*, also has the modified flagellar segment in the male.

Diandrena is found from the Rocky Mountains westward.

Names Applied to North American Species of the Subgenus Diandrena

ablegata (Cockerell) 1922:1
atypica (Cockerell) 1941:347
austrocalifornica Viereck 1916:587
beatula (Cockerell) 1916:48
chalybaea (Cresson) 1878:61
chalybioides (Viereck) 1904:229
clariventris (Cockerell) 1916:50
cuneilabris Viereck 1926:400
cyanosoma (Cockerell) 1916:49
foxii Cockerell 1898:188
gnaphalii (Cockerell) 1938:148
marinensis (Cockerell) 1936:153
nothocalaidis (Cockerell) 1905:183
olivacea Viereck 1916:590
parachalybea Viereck 1917:391
perchalybea Viereck 1916:591

Names Applied to North American Species of the
Subgenus Diandrena (*Continued*)

purdyi (Cockerell) 1936:155	*sperryi* (Cockerell) 1937:14
puthua (Cockerell) 1910:24	*subchalybea* Viereck 1916:593
sanctorum (Cockerell) 1941:346	*submoesta* Viereck 1916:594

27. **Leucandrena** Hedicke

Leucandrena Hedicke 1933:215.

Medium- to large-sized species; integument black, posterior margins of terga more or less yellowish; male with clypeus black.

Female.—Facial fovea wide, upper end occupying more than one-half distance between eye and lateral ocellus; antenna with segment 3 of variable length, slightly shorter than to longer than segments 4 + 5; process of labrum entire; maxillary palpus extending well beyond tip of galea, conspicuously longer than labial palpus. Thorax with none of pubescence black; enclosure of propodeum finely sculptured or moderately coarsely sculptured; propodeal corbicula well developed, with compact fringe of hairs anteriorly, interior either free of hairs or hairy throughout. Tibial scopa moderately compact, hairs of anterior margin unusually long, and often lighter in color than rest of scopa, outer face composed of simple or obscurely branched hairs; trochanteral floccus perfect, well developed; middle basitarsus not conspicuously widened at middle, subequal to hind basitarsus in width. Forewing with three submarginal cells, first recurrent nervure ending from the middle to two-thirds of the distance toward end of second submarginal cell. Terga impunctate, posterior margins with more or less conspicuous, rather loose appressed hair bands.

Male.—Head shape variable; antenna with segment 3 longer than 4; cheek much wider or only about as wide as eye; mandibles long and decussate or rather short and only slightly decussate. Genitalia with parapenial lobes strongly produced, rounded, aedeagus slender or moderately expanded basally, sides excavated or not.

Type.—*Apis sericea* Christ 1791. (Original designation.)

Leucandrena is characterized by the well-developed propodeal corbicula, entire process of the labrum, and weak to conspicuous tergal bands. The New World species here assigned to this group are rather diverse, and this treatment of them is not entirely satisfactory.

Names Applied to North American Species of the
Subgenus Leucandrena

electrica Casad and Cockerell 1896:89	*peckhami* Cockerell 1902:105
erythronii Robertson 1891:53	*perezana* Viereck and Cockerell 1914:47
lupini Cockerell 1936:142	*placida* Smith 1853:112
macgillivrayi Cockerell 1897:308	*salicacea* Robertson 1900:48
macilenta Provancher 1888:313	*sapellonis* Cockerell 1900:19
parnassiae Cockerell 1902:105	*trapezoidina* Viereck and Cockerell 1914:58

Names Provisionally Assigned to Leucandrena

albisigna Viereck 1922:38
complicata Viereck 1916:554
mariposorum Viereck 1917:382
nigrovaria Viereck 1924:237

28. **Melandrena** Pérez

Melandrena Pérez 1890:170; Hedicke 1933:216; Linsley 1938:264.

Medium-sized to rather large species; integument usually black, occasionally red or metallic blue; clypeus of male concolorous with integument of rest of face.

Female.—Facial fovea wide, upper end occupying more than one-half distance between

eye and lateral ocellus; process of labrum reflexed at tip, emarginate; segment 3 of antenna slightly shorter than or equal to 4 + 5; maxillary palpus extending well beyond tip of galea, conspicuously longer than labial palpus. Thorax always with black pubescence; pleura rather coarsely sculptured; enclosure of propodeum coarsely wrinkled, declivity rounded or subcarinate; propodeal corbicula poorly developed, no fringe of hairs anteriorly, dorsal fringe short or not definitive, interior hairy throughout. Tibial scopa very loose and coarse or moderately compact, hairs of outer face simple; trochanteral floccus variable, from perfect and moderately well developed to imperfect and poorly developed; middle basitarsus not conspicuously expanded in middle, not wider than hind basitarsus. Forewing with 3 submarginal cells, first recurrent nervure nearly always ending beyond middle of cell. Terga distinctly punctate or punctate-tessellate, posterior margins without hair bands.

Male.—Facial quadrangle longer than wide; antenna with segment 3 equal to or longer than 4. Genitalia with tips of parameres expanded, parapenial lobes strongly produced, acute; aedeagus slender, moderately excavated at sides.

Type.—*Andrena morio* Brullé 1832. (By designation of Hedicke 1933:216.)

A. morio Brullé of the Old World, the type species, differs from most American forms in the venation, the first recurrent nervure reaching the submarginal cell near the middle. The first flagellar segment is also unusually long. However, the American series seems to be otherwise very much like this species, the coarsely sculptured thorax, the emarginate process of the labrum, poorly developed corbicula, and similar *habitus* being significant.

Most of the species of *Melandrena* have all the pubescence black; rarely the dorsum of the thorax has fulvous hair. The group is characterized structurally by the coarsely sculptured thorax and generally reflexed and emarginate process of the labrum. The Old World *Glyphandrena* differs by having the posterior spur of the hind tibia strongly widened basally.

In North America, the subgenus is found from the Rocky Mountains westward; it occurs also in the Old World.

Names Applied to North American Species of the Subgenus Melandrena

anograe Cockerell 1901:154
bernardina Linsley 1938:275
blaisdelli Cockerell 1924:59
deserticola Timberlake 1937:73
flandersi Timberlake 1937:72
griseonigra Cockerell 1905:371
linsleyi Timberlake 1937:71
micranthophila Cockerell 1906:432
nigra Provancher 1895:173
oenotherae Timberlake 1937:69
omninigra Viereck 1917:385
prima Casad 1896:78
rubrotincta Linsley 1938:278
subtristis Cockerell 1905:372
vanduzeei Linsley 1938:280

Names Provisionally Referred to Melandrena

cerasifolii Cockerell 1896:220
grundeli Linsley 1938:274
mimetica Cockerell 1903:412
mimetica falli Cockerell 1907:536

29. **Gymnandrena** Hedicke

Gymnandrena Hedicke 1933:213.

Medium- to large-sized species; integument usually black, occasionally metallic blue; male with clypeus not yellow or white.

Female.—Facial fovea wide in the larger species, in a few medium-sized species upper end of fovea may occupy less than one-half distance between eye and lateral ocellus; segment 3 of antenna longer than 4 + 5; process of labrum large, flat, not conspicuously emarginate;

maxillary palpus extending well beyond tip of galea, conspicuously longer than labial palpus. Thorax with or without black pubescence; enclosure of propodeum often moderately coarsely wrinkled basally, but finely sculptured over most of area; propodeal corbicula moderately well developed, often some branched hairs along anterior margin, but not forming a dense and conspicuous fringe, interior of corbicula hairy throughout. Tibial scopa compact, hairs of outer face simple, trochanteral floccus imperfect; middle basitarsus not conspicuously widened at middle, subequal to hind basitarsus in width. Forewing with three submarginal cells, first recurrent nervure meeting second submarginal cell before to slightly beyond middle. Terga usually rather weakly punctate-tessellate, posterior margins usually without hair bands, but occasionally incomplete, or rarely complete bands present.

Male.—Facial quadrangle somewhat longer than wide; antenna with segment 3 subequal to or longer than 4; cheek variable, narrow to moderately broad, but not sharply angled behind; mandibles variable, short and apposite to moderately long and decussate. Genitalia with tips of parameres long and slender, parapenial lobes slightly produced; aedeagus slender or moderately expanded basally, sides not excavated.

Type.—*Apis thoracica* Fabricius 1775. (Original designation.)

The type species, *A. thoracica* (Fabr.), of the Old World, differs from the American forms in having the process of the labrum rather strongly emarginate, but agrees otherwise very closely with the American species.

In general appearance much like *Cryptandrena*, this subgenus is characterized by the imperfect trochanteral floccus of the female and the narrow parameres of the male genitalia.

The group is widespread in the United States, and is found also in the Old World.

Names Applied to the North American Species of the Subgenus Gymnandrena

argentiniae trichomelaena Cockerell 1913: 376
carliniformis Viereck and Cockerell 1914:25
commoda Smith 1879:53
confederata Viereck 1917:375
corni Robertson 1900:50
errans Smith 1879:55
hilaris Smith 1853:112
lupinorum Cockerell 1906:308
nigripes Provancher 1895:173
nivalis Smith 1853:118
perimelas Cockerell 1905:371
pertristis Cockerell 1905:372
pyrura Cockerell 1906:309
sayi Robertson 1891:52
semirufa Cockerell 1900:407
vicina Smith 1853:112
vicina argentiniae Cockerell 1906:432
victima Smith 1853:113
wilmattae Cockerell 1906:224

Names Provisionally Applied to Gymnandrena

epileuca Cockerell 1924:62
lupinorum helenae Cockerell 1934:2
lustrans Cockerell 1924:63
nigrihirta (Ashmead) 1890:6
nigrocaerulea Cockerell 1897:309
pulverulenta Viereck 1904:221

A. merriami Cockerell 1901:284 and *A. fulvinigra* Viereck and Cockerell 1914:42 have the appearance of small *Gymnandrena*, but the foveae are very narrow. They should perhaps form a group near *Gymnandrena* and *Cryptandrena*.

30. **Cryptandrena** Lanham, new subgenus

Medium- to large-sized species; integument usually black, occasionally metallic blue or red; male with clypeus not yellow or white.

Female.—Facial fovea wide, upper end occupying much more than one-half distance between eye and lateral ocellus; antenna with segment 3 subequal to 4 + 5; process of labrum large, flat, not conspicuously emarginate; maxillary palpus extending well beyond tip of galea, conspicuously longer than labial palpus. Thorax with or without black pubes-

cence; enclosure of propodeum often moderately coarsely wrinkled basally; propodeal corbicula moderately well developed, often with some branched hairs anteriorly, but these do not form a compact fringe, interior hairy throughout. Tibial scopa long, compact, outer face with simple hairs; trochanteral floccus perfect, well developed; middle basitarsus not widened at middle, subequal in width to hind basitarsus. Forewings with three submarginal cells, first recurrent nervure reaching second submarginal cell at or near middle of cell. Terga impunctate to rather distinctly punctate, posterior margins nearly always without hair bands, but rarely weak lateral patches of hair present.

Male.—Shape of facial quadrangle variable; antenna with segment 3 equal to or longer than 4; cheek much wider than eye; mandibles long, decussate. Genitalia with tips of parameres more or less expanded, parapenial lobes slightly to strongly produced; aedeagus moderately to strongly expanded basally, sides not excavated.

Type.—Andrena carlini Cockerell 1901:150.

Cryptandrena is very much like *Gymnandrena* in general appearance, its members being mostly robust species with large and generally entire process of the labrum and without hair bands or abundant erect hair on the terga. Females differ from *Gymnandrena* in having the trochanteral floccus complete, the males in having the tips of the parameres more strongly expanded.

It is widely distributed in the United States.

Names Applied to the North American Species of the Subgenus Cryptandrena

annae Cockerell 1931:200
belfragei Cresson 1872:256
brunniventris Cresson 1872:258
bryanti Cockerell 1938:5
carissima Cockerell 1924:58
carlini Cockerell 1901:150
cyanura Cockerell 1916:252
dunningi Cockerell 1898:103
ensenadensis Cockerell 1941:345
erythrogastra (Ashmead) 1890:6
heterura Cockerell 1929:445
microdonta Cockerell 1924:61
perezi Robertson 1891:51
perplexa Smith 1853:118
pluvialis Cockerell 1901:154
pruni Robertson 1891:51
regularis Malloch 1917:91
rhodura Cockerell 1898:171
semicyanea Cockerell 1924:58
sola Viereck 1916:577
subaustralis Cockerell 1898:146
subnigripes Viereck 1916:581
subtilis Smith 1879:55
transnigra Viereck 1904:223
transnigra paysoni Cockerell 1924:349
viburnella Graenicher 1903:165
viciniformis Robertson 1900:47
viridinitens Cockerell 1936:152

The following names have been applied to species probably belonging to either *Cryptandrena* or *Gymnandrena;* re-examination of the types is necessary to place them definitely in one or the other of the two subgenera.

beutenmulleri Viereck 1916:729
compactiscopa Viereck 1904:222
convexa Provancher 1888:311
hallii Dunning 1898:268
junonia Viereck 1904:222
meadowsi Cockerell 1938:146
obscuripennis Smith 1853:118
purpurina Viereck and Cockerell 1914:16
rufojugata Cockerell 1931:17
scotoptera Cockerell 1934:1
seminigra Viereck 1904:221
solidula Viêreck 1904:222
spaldingi Cockerell 1934:3
subarctica Cockerell 1936:282
vicinoides Viereck 1904:223

31. **Scoliandrena** Lanham, new subgenus

Medium-sized species; integument metallic blue or black; male with clypeus not yellow or white.

Female.—Facial fovea wide, upper end occupying more than one-half distance between eye and lateral ocellus; segment 3 of antenna longer than 4 + 5; process of labrum large,

triangular, entire; outer surface of galea and apical one-third of posterior surface of prementum with many short, hooked bristles, galea slender, maxillary palpus reduced, conspicuously shorter than galea. Thorax with or without black pubescence; enclosure of propodeum finely sculptured; propodeal corbicula rather poorly developed, no fringe of hairs anteriorly, interior with simple hairs on posterior one-half. Tibial scopa compact, hairs of outer face simple; trochanteral floccus nearly perfect, not well developed; middle basitarsus not conspicuously widened at middle, subequal in width to hind basitarsus. Forewing with three submarginal cells, first recurrent nervure meeting second submarginal cell near middle of cell; pterostigma slender. Terga strongly reticulate, punctate or impunctate, posterior margins without hair bands.

Male.—Facial quadrangle about as long as wide; antenna with segment 3 longer than 4. Genitalia with parapenial lobes moderately produced, rounded; aedeagus expanded basally, sides not excavated.

Type.—*Andrena osmioides* Cockerell 1916:45.

Scoliandrena is established to include robust, *Gymnandrena*-like species which have the mouthparts modified so as to assist in collecting pollen from flowers of *Cryptantha* or flowers with similar structure. The strongly reticulate terga and prominent triangular process of the labrum are also diagnostic. Michener (1944:218) has pointed out that the outer surface of the galea and apical portion of the posterior surface of the prementum of *A. osmioides* Cockerell are covered with hooked setae, and that this same adaptation has arisen in certain megachilid bees, which also collect pollen from *Cryptantha*. In addition to the hooked setae, the mouthparts of *Scoliandrena* are unusual in respect to the strongly reduced maxillary palpi and the slender galea. Similar hooked setae occur on the mouthparts of *A.* (*Micrandrena*) *timberlakei* Cockerell, also a collector of *Cryptantha* pollen.

The single described species (the type) known to belong to *Scoliandrena*, and two or three undescribed species, are known only from California.

SPECIES OF UNCERTAIN POSITION

The following names have been applied to species known only from the males, and cannot at the present time be referred to subgenera.

agricolarum Viereck and Cockerell 1914:29
angustella Cockerell 1936:136
angustifovea Viereck 1904:194
aureocincta Cockerell 1896:88
azygos Viereck 1916:550
berkeleyi Viereck and Cockerell 1914:19
caeruleonitens Viereck 1926:1
capricornis Casad and Cockerell 1896:182
colletoides Viereck and Cockerell 1914:27
cragini Cockerell 1899:254
dallasiana Cockerell 1910:262
desponsa Smith 1853:114
durangoensis Viereck and Cockerell 1914:36
elongatula Viereck 1917:378
enceliarum Cockerell 1937:13
fernaldiella Viereck and Cockerell 1914:34
hirticeps Smith 1853:116
innominata Viereck 1926:404
interrogationis Viereck and Cockerell 1914:35
jennei Viereck 1916:561
jessicae Cockerell 1896:79
lappulae Cockerell 1906:437
laramiensis Viereck and Cockerell 1914:22
littlefieldi Viereck 1916:563
marina Viereck 1926:405
media Viereck 1922:41
mellitarsis Viereck 1917:384
mesillae Cockerell 1896:90
microsoma Viereck 1904:194
monilicornis Cockerell 1896:181
moquiorum Viereck and Cockerell 1914:21
navajorum Viereck and Cockerell 1914:29
nigrifrons Cresson 1878:62
occidentalis Cockerell 1896:87
padoucorum Viereck and Cockerell 1914:38
ripariella Cockerell 1936:148

stenosoma Viereck 1925:135
subaustraliformis Viereck and Cockerell 1914:28
tetonorum Viereck and Cockerell 1914:24
texana Cresson 1872:258
vancouverensis Viereck 1924:80
vestali Cockerell 1913:64
vestali dolichocera Viereck and Cockerell 1914:19
vulgaris Viereck 1922:40
yaquiorum Viereck 1917:397
yumorum Viereck 1916:585

The following names have been applied to species which, although the females are known, cannot be placed in the subgeneric classifications until the types have been reëxamined.

albuginosa (Viereck) 1904:228
aliena Smith 1853:113
angusi Viereck 1907:284
banksi Malloch 1917:89
cornelli Viereck 1907:282
davisi Viereck 1907:283
decussatula Viereck 1904:225
distans Provancher 1888:307
fragiliformis Cockerell 1906:435
fulvihirta Viereck and Cockerell 1914:54
inclinata Viereck 1916:559
indotata Viereck 1904:222
lawrencei Viereck and Cockerell 1914:15
longihirtiscopa Viereck 1904:223
mustelicolor Viereck 1904:196
nigerrima Casad 1896:83
nigerrima pineti Cockerell 1931:13
nivaloides Graenicher 1911:235
nubilipennis Viereck 1904:226
obscuripostica Viereck 1916:568
perindotata Viereck 1908:42
phenax Cockerell 1898:188
potentillarum Viereck 1924:79
pullmani Viereck 1904:223
pulverea Viereck 1916:569
sancta Viereck 1916:571
seattlensis Viereck 1904:223
semipolita Viereck 1904:225
stictigastra Viereck 1916:579
tumida Viereck 1922:35

LIST OF NAMES

Applied to the

Andrena of America North of Mexico, with Subgeneric Assignments

abacta (? Micrandrena)
abjuncta (Trachandrena)
ablegata (Diandrena)
ablusula (Thysandrena)
accepta (Pterandrena)
acrypta (Ptilandrena)
adelae (Thysandrena)
advarians (Andrena)
agricolarum (position uncertain)
alamonis (Trachandrena)
albiculta (Elandrena)
albihirta (Andrena)
albisigna (? Leucandrena)
albofoveata (Mimandrena)
albosellata (Andrena)
albovirgata (Cnemidandrena)
albuginosa (position uncertain)
algida (Gonandrena)
aliciae (Pterandrena)
aliciarum (Pterandrena)
aliena (position uncertain)
alleghaniensis (Trachandrena)
americana (Cnemidandrena)
amphibola (Trachandrena)
amplificata (Elandrena)
andrenoides (Parandrena)
andrenoides bicolor (Parandrena)
andrenoides clarigastra (Parandrena)
angusi (position uncertain)
angustella (position uncertain)
angustifovea (position uncertain)
angustifrons (Conandrena)
angustitarsata (Simandrena)
angustitarsata huardi (Simandrena)
anisochlora (? Oligandrena)
annae (Cryptandrena)
anograe (Melandrena)
antonitonis (Cnemidandrena)
apacheorum (Cnemidandrena)
arabis (Scaphandrena)
argemonis (Schizandrena)
argentiniae trichomelaena (Gymnandrena)
argentiscopa (Thysandrena)
arizonensis (Schizandrena)
ashmeadi (Pterandrena)
asmi (Andrena)
asteris (Pterandrena)
astragali (Xanthandrena)
atala (Ptilandrena)
atypica (Diandrena)

aureocincta (position uncertain)
auricauda (Trachandrena)
auricoma (Xanthandrena)
austrocalifornica (Diandrena)
autumnalis (Cnemidandrena)
azygos (position uncertain)
baeriae (Hesperandrena)
banffensis (Andrena)
banksi (position uncertain)
barbarica (Gonandrena)
barberi (Pterandrena)
beatula (Diandrena)
bebbiana (Andrena)
beckeri (Thysandrena)
belfragei (Cryptandrena)
bella (Andrena)
berberidis (Dactylandrena)
berkeleyi (position uncertain)
bernardina (Melandrena)
beulahensis (Cnemidandrena)
beutenmulleri (Gymnandrena or Cryptandrena)
bipunctata (? Micrandrena)
birtwelli (Andrena)
birtwelli subatrata (Andrena)
bisalicis (Thysandrena)
biscutellata (Pterandrena)
blaisdelli (Melandrena)
boharti (Thysandrena)
braccata (Pterandrena)
brachycarpae (Thysandrena)
bradleyi (Conandrena)
brevibasis (Trachandrena)
brevipalpis (Thysandrena)
bridwelli (Opandrena)
bruneri (Elandrena)
brunniventris (Cryptandrena)
bryanti (Cryptandrena)
buckelli (Andrena)
caerulea territa (Ptilandrena)
caeruleonitens (position uncertain)
caliginosa (Dactylandrena)
campanulae (Thysandrena)
campbelli (Pterandrena)
canadensis (Cnemidandrena)
canadensis oslarella (Cnemidandrena)
candida (Thysandrena)
candida tramoserica (Thysandrena)
candidiformis (Micrandrena)
capricornis (position uncertain)
carissima (Cryptandrena)
carlini (Cryptandrena)
carliniformis (Gymnandrena)
carolina (Conandrena)
carrikeri (Andrena)
casadae (position uncertain)
catalinica (Micrandrena)
ceanothi (Trachandrena)
ceanothifloris (Andrena)
ceanothina (Thysandrena)
cerasifolii (? Melandrena)
cercocarpi (? Micrandrena)
chalybaea (Diandrena)
chalybioides (Diandrena)
chapmanae (Elandrena)
cheyennorum (Conandrena)
chlorinella (? Micrandrena)
chlorogaster (Micrandrena)
chlorura (Thysandrena)
chromotricha (Cnemidandrena)
citrinihirta (Cnemidandrena)
claremonti (Thysandrena)
clariventris (Diandrena)
clarkella (Andrena)
claytoniae (Mimandrena)
clementina (Thysandrena)
cleodora (Trachandrena)
clypeata (? Micrandrena)
clypeolata (? Micrandrena)
clypeonitens (Cnemidandrena)
clypeoporaria (Andrena)
coactifera (Trachandrena)
coactipostica (Aporandrena)
cockerelli (Andrena)
coerulea (Ptilandrena)
colletina (Cnemidandrena)
colletoides (position uncertain)
coloradina (Thysandrena)
colombiana (Cnemidandrena)
commoda (Gymnandrena)
compactiscopa (Gymnandrena or Cryptandrena)
complexa (Ptilandrena)
complicata (? Leucandrena)
concinnula (Parandrena)
confederata (Gymnandrena)
convexa (Gymnandrena or Crytpandrena)
cornelli (position uncertain)
corni (Gymnandrena)
corrugata (Trachandrena)
costillensis (Cnemidandrena)
costillensis indecisa (Cnemidandrena)
cragini (position uncertain)
crassihirta (Trachandrena)
crataegi (Schizandrena)
crataegiphila (Trachandrena)
crawfordi (Pterandrena)
cressonii (Opandrena)
cressonii transformans (Opandrena)
cristata (Thysandrena)
crypta (Ptilandrena)
cuneilabris (Diandrena)

cupreotincta (Trachandrena)
cyanophila (Trachandrena)
cyanosoma (Diandrena)
cyanura (Cryptandrena)
daecki (Trachandrena)
dallasiana (position uncertain)
davidsoni (? Cnemidandrena)
davisi (position uncertain)
davisiana (Trachandrena)
decussata (Thysandrena)
decussatula (position uncertain)
delta (Andrena)
deserticola (Melandrena)
desponsa (position uncertain)
determinata (Pterandrena)
didelta (Andrena)
dinognatha (? Oligandrena)
discolor (Thysandrena)
distans (position uncertain)
diversicolor (Andrena)
dolichotricha (position uncertain)
dubia (Opandrena)
dunningi (Cryptandrena)
durangoensis (position uncertain)
edwardsi (Andrena)
edwiniae (Andrena)
electrica (Leucandrena)
ellisiae (Scaphandrena)
elongatula (position uncertain)
enceliarium (position uncertain)
enigmatica (Andrena)
enocki (Parandrena)
ensenadensis (Cryptandrena)
epileuca (? Gymnandrena)
erecta (Andrena)
erigeniae (Ptilandrena)
erigenoides (Ptilandrena)
eriogoni (Trachandrena)
errans (Gymnandrena)
erythrogastra (Cryptandrena)
erythronii (Leucandrena)
escondida (Hesperandrena)
eumorpha (Parandrena)
excellens (Andrena)
extensa (? Dactylandrena)
fenningeri (Trachandrena)
fernaldiella (position uncertain)
fimbriata (Cnemidandrena)
flandersi (Melandrena)
flavoclypeata (? Micrandrena)
flexa (? Thysandrena)
forbesii (Trachandrena)
foxii (Diandrena)
fracta (Schizandrena)
fragariana (Micrandrena)
fragiliformis (position uncertain)
fragilis (Gonandrena)
francisca (Ptilandrena)
friesei (Simandrena)
frigida (Andrena)
fulvicrista (Andrena)
fulvihirta (position uncertain)
fulvinigra (? Gymnandrena)
fulvipennis (Pterandrena)
fuscicauda (Trachandrena)
fuscisignata (Thysandrena)
gardineri (Pterandrena)
garretti (Parandrena)
geranii (Thysandrena)
gibberis (Parandrena)
g. maculati (Ptilandrena)
gnaphalii (Diandrena)
graenicheri (Pterandrena)
grandior (Trachandrena)
griseonigra (Melandrena)
grundeli (? Melandrena)
hadra (Trachandrena)
halli (Gymnandrena or Cryptandrena)
hartfordensis (Simandrena)
harveyi (Andrena)
haynesi (Pterandrena)
helianthi (Pterandrena)
helianthiformis (Pterandrena)
hemileuca (Andrena)
heraclei (Trachandrena)
heterura (Cryptandrena)
hicksi (Elandrena)
hilaris (Gymnandrena)
hippotes (Trachandrena)
hirsutula (? Ptilandrena)
hirticeps (position uncertain)
hirticincta (Cnemidandrena)
hirticincta surda (Cnemidandrena)
hitei (Andrena)
hypoleuca (Simandrena)
idahorum (Andrena)
illinoiensis (Micrandrena)
illinoiensis bicolor (Micrandrena)
imitatrix (Mimandrena)
imitatrix profunda (Mimandrena)
impuncta (Andrena)
inclinata (position uncertain)
indianensis (Trachandrena)
indotata Viereck 1904:222 (position uncertain)
indotata (Viereck) 1904:160 (Trachandrena)
innominata (position uncertain)
integra (Gonandrena)
interrogationis (position uncertain)
irana (Oligandrena)
jacobaea (Andrena)

jennei (position uncertain)
jessicae (position uncertain)
jockorum (Trachandrena)
johnsoniana (Mimandrena)
junonia (Gymnandrena or Cryptandrena)
kalmiae (Trachandrena)
kansensis (Opandrena)
kincaidii (Schizandrena)
kincaidii pascoensis (Schizandrena)
knuthiana (Thysandrena)
lamellicauda (Pterandrena)
laminibucca (Andrena)
lappulae (position uncertain)
laramiensis (position uncertain)
lata (Thysandrena)
laticeps (Gonandrena)
latisigna (Opandrena)
lauracea (Pterandrena)
lawrencei (position uncertain)
leptanthi (Dactylandrena)
lewisii (? Andrena)
lillooetensis (Andrena)
limarea (Trachandrena)
lincolnella (Pterandrena)
lincolni (Trachandrena)
lineata (Gonandrena)
linsleyi (Melandrena)
littlefieldi (position uncertain)
longihirtiscopa (position uncertain)
lucifera (Gonandrena
lummiorum (Andrena)
lupini (Leucandrena)
lupinorum (Gymnandrena)
lupinorum helenae (? Gymnandrena)
lustrans (? Gymnandrena)
lutzi (Trachandrena)
macgillivrayi (Leucandrena)
macilenta (Leucandrena)
mackiae (? Scaphandrena)
macoupinensis (Andrena)
macrocephala (Oligandrena)
macrocephala tetleyi (Oligandrena)
magnifica (Andrena)
mandibularis (Andrena)
manifesta (Callandrena)
mariae (Trachandrena)
mariae concolor (Trachandrena)
marina (position uncertain)
marinensis (Diandrena)
marioides (Trachandrena)
mariposorum (? Leucandrena)
martialis (Trachandrena)
maura (Dactylandrena)
meadowsi (Gymnandrena or Cryptandrena)
media (position uncertain)
medionitens (Thysandrena)
melanochroa (Micrandrena)
melanodora (Trachandrena)
mellea (Schizandrena)
mellitarsis (position uncertain)
melliventris (Pterandrena)
mendosa (Parandrena)
mentzeliae (Cnemidandrena)
merriami (? Gymnandrena)
mesillae (position uncertain)
mesoleuca (Andrena)
metea (Oligandrena)
micranthophila (Melandrena)
microchlora (Micrandrena)
microchlora subalia (Micrandrena)
microdonta (position uncertain)
microsoma (position uncertain)
milwaukeensis (Andrena)
mimetica (? Melandrena)
mimetica falli (? Melandrena)
miranda (Trachandrena)
miserabilis (? Micrandrena)
moesta (Andrena)
moesticolor (? Andrena)
monilicornis (position uncertain)
monogonoparia (Andrena)
montrosensis (Scaphandrena)
moquiorum (position uncertain)
morrisonella (Trachandrena)
moscovensis (Trachandrena)
multiplicata (Trachandrena)
multiplicatiformis (Trachandrena)
mustelicolor (position uncertain)
nasonii (Simandrena)
nasonii fulvodorsata (Simandrena)
navajorum (position uncertain)
neonana (? Micrandrena)
nuerona (Dactylandrena)
nevadensis (Parandrena)
nigerrima (position uncertain)
nigerrima pineti (position uncertain)
nigra (Melandrena)
nigrae (Micrandrena)
nigrifrons (position uncertain)
nigrihirta (? Gymnandrena)
nigripes (Gymnandrena)
nigritarsis (Micrandrena)
nigrocaerulea (? Gymnandrena)
nigroclypeata (Oligandrena)
nigrovaria (? Leucandrena)
nitidarum (? Andrena)
nitidicornis (Micrandrena)
nitidior (Pterandrena)
nivalis (Gymnandrena)
nivaloides (position uncertain)
nodosa (Andrena)

nortoni (Trachandrena)
nothocalaidis (Diandrena)
nothoscordi (Micrandrena)
novaeangliae (Thysandrena)
nubecula (Cnemidandrena)
nubecula tristicornis (Cnemidandrena)
nubilifascia (Ptilandrena)
nubilipennis (position uncertain)
nuda (Trachandrena)
nudimediocornis (? Ptilandrena)
nudiscopa (Simandrena)
obscura (Trachandrena)
obscuripennis (Gymnandrena or Cryptandrena)
obscuripostica (position uncertain)
occidentalis (position uncertain)
ochreopleura (Trachandrena)
oenotherae (Melandrena)
olivacea (Diandrena)
omninigra (Melandrena)
oniscicolor (? Ptilandrena)
opacibasis (Simandrena)
opacissima (Simandrena)
opaciventris (Simandrena)
orthocarpi (Simandrena)
osmioides (Scoliandrena)
pacifica (Micrandrena)
pacta (? Cnemidandrena)
padoucorum (position uncertain)
paenefulva (Andrena)
paenerugosa (Trachandrena)
pallida (Andrena)
pallidifovea (Stenandrena)
pallidiscopa (? Ptilandrena)
pallidiscopa trifasciata (? Ptilandrena)
papagorum (Parandrena)
parachalybea (Diandrena)
parnassiae (Leucandrena)
peckhami (Leucandrena)
pecosana (Pterandrena)
pectidis (Callandrena)
pediculihirta (Ptilandrena)
pennsylvanicola (? Micrandrena)
pensilis (Simandrena)
perarmata (Andrena)
peratra (Oligandrena)
perchalybea (Diandrena)
perdensa (Trachandrena)
perezana (Leucandrena)
perezana thaspiiformis (Andrena)
perezi (Cryptandrena)
perforatella (Trachandrena)
perimelas (Gymnandrena)
perindotata (position uncertain)
permitis (Pterandrena)
pernuda (Trachandrena)
perplexa (Cryptandrena)
persimilis (Cnemidandrena)
persimulata (Gonandrena)
personata (Micrandrena)
pertarda (Cnemidandrena)
pertristis (Gymnandrena)
phenax (position uncertain)
phocata (Thysandrena)
physariae (Scaphandrena)
piperi (Micrandrena)
placida (Leucandrena)
placitae (Micrandrena)
plana (Scaphandrena)
platyparia (Gonandrena)
platyrhina (? Scaphandrena)
plumifera (Stenandrena)
pluvialis (Cryptandrena)
polemonii (Ptilandrena)
politissima (Trachandrena)
polygoni (position uncertain)
porterae (Dactylandrena)
postnitens (Trachandrena)
potentillarum (position uncertain)
prima (Melandrena)
primulifrons (Micrandrena)
profundiformis (Trachandrena)
pronitens (? Micrandrena)
provancheri (Gonandrena)
pruni (Cryptandrena)
prunicola (Trachandrena)
pruniforis (? Opandrena)
prunorum (Schizandrena)
prunorum gilletei (Schizandrena)
prunorum mariformis (Schizandrena)
prunorum pauperatula (Schizandrena)
pulchella (Pterandrena)
pullmani (position uncertain)
pulverea (position uncertain)
pulverulenta (? Gymnandrena)
purdyi (Diandrena)
purpurina (Gymnandrena or Cryptandrena)
puthua (Diandrena)
pyrrhacita (Andrena)
pyrrhacita coloradensis (Andrena)
pyrrhacita mosina (Andrena)
pyrura (Gymnandrena)
quintiliformis (Trachandrena)
quintilis (Trachandrena)
radiatula (Trachandrena)
radmitricha (Pterandrena)
ramaleyi (Cnemidandrena)
reflexa (Pterandrena)
regularis (Cryptandrena)
rehni (Trachandrena)
revelstokensis (Andrena)

trivialis (Ptilandrena)
trizonata (Thysandrena)
trumani (Opandrena)
truncata (Cnemidandrena)
tumida (position uncertain)
unicula (Elandrena)
vagans (Micrandrena)
vancouverensis (position uncertain)
vanduzeei (Melandrena)
vandykei (Micrandrena)
varia (Andrena)
varians (? Andrena)
vegana (Micrandrena)
verbesinae (Callandrena)
verecunda (Pterandrena)
veris (Trachandrena)
vestali (position uncertain)
vestali dolichocera (position uncertain)
vernoni (? Schizandrena)
viburnella (Cryptandrena)
vicina (Gymnandrena)
vicina argentiniae (Gymnandrena)
viciniformis (Cryptandrena)
vicinoides (Gymnandrena or Cryptandrena)
victima (Gymnandrena)
vierecki (Thysandrena)
violae (Iomelissa)
viridibasis (Elandrena)
viridinitens (Cryptandrena)
vulgaris (position uncertain)
walleyi (Elandrena)
washingtoni (Andrena)
washingtoni manitouensis (Andrena)
weedi (Trachandrena)
wellesleyana (Parandrena)
wheeleri (Simandrena)
wheeleri pallidior (Simandrena)
wilkella (Taeniandrena)
wilmattae (Gymnandrena)
winkleyi (Taeniandrena)
w-scripta (Thysandrena)
xanthigera (Cnemidandrena)
xanthostigma (Thysandrena)
yaquiorum (position uncertain)
yosemitensis (Elandrena)
yumorum (position uncertain)
zizae (Micrandrena)
ziziaeformis (? Micrandrena)
zygadeni (Xanthandrena)

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ALPHABETICAL INDEX TO SUBGENERA

THE NORTH AMERICAN GALL MIDGES OF THE TRIBE LESTREMIINI; ITONIDIDAE (CECIDOMYIIDAE); DIPTERA

BY

A. EARL PRITCHARD

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THE NORTH AMERICAN GALL MIDGES OF THE TRIBE LESTREMIINI; ITONIDIDAE (CECIDOMYIIDAE); DIPTERA

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INTRODUCTION

THE CLASSIFICATION of the lestremiine gall midges has been neglected in North America. Felt (1913) presented a review of the nearctic species; but his treatment was based on a very few individuals, and many characters he used for differentiation of species have proved to be invalid. Felt described a total of twenty-seven species in the tribe Lestremiini, of which twenty-three were based on a single specimen each. Ten of Felt's species are here considered valid. Malloch and Cockerell each described a single species, and both of these are here considered to be synonyms.

The present revision is based on a study of all the types of all species of Lestremiini described from North America as well as a large amount of additional material, most of which was collected by the writer in Minnesota, California, and Washington.

This article completes a revision of the subfamily Lestremiinae in North America. The tribe Micromyini was treated by Pritchard (1947), and the tribes Catotrichini and Catochini were treated by Pritchard (1948). The tribe Strobliellini is based on *Strobliella intermedia* Kieffer, a species known only from Europe.

The morphological terms employed were explained by Pritchard (1947, 1948). Particular attention is called to the wing venation, in that the short portion of the radial sector before the r-m cross vein is called R_s, and the long distal portion is termed R_5 for convenience; vein M_{3+4} (Cu_1 in part of other workers) is recognized as a branch of M or as a free vein between M and Cu, whereas Cu_1 is recognized only as a branch of Cu; the first vein behind Cu is called the posterior cubitus (PCu), and the second vein behind Cu is referred to as the plical vein (Pl).

In regard to the hypopygium, the ninth tergite and the tenth tergite and sternite are referred to as such, and the two segments of the forceps or claspers are termed the basiforceps and distiforceps respectively. The phallosome consists of a platelike structure above, proximally united to the basiforceps, which is called the tegmen, and a rodlike structure below, which is called the genital rod.

Gall midges are usually mounted on slides for critical study. The technique used by the writer for slide preparation is similar to that used by certain other dipterists, but it is probably new for students of gall midges. The wings are first removed from the specimen preserved in alcohol (or pinned, dry) and placed in a small container of methyl cellosolve. The body contents are then completely macerated in about ten per cent potassium hydroxide, which is warmed for several minutes. After this the specimen is placed in distilled water for several minutes and then transferred to the methyl cellosolve for about one minute. The wings and body are placed in a drop of thin Canada balsam on a cover glass. The appendages are

arranged, and the head and genitalia are oriented as desired. After drying for several hours, the cover glass is inverted onto a drop of thicker balsam on a slide.

Felt's descriptions were usually unaccompanied by information concerning the number of types. The size of the type series of his species and their disposition are indicated in the present paper. Lectotypes have been selected when feasible.

Because the Felt collection at the New York State Museum is of such fundamental importance to workers in the group, it has been the aim of the writer to show all the material represented there. Specimens in the Felt collection that are not regarded as types are indicated by the notations "determined . . . by Felt" or "undetermined by Felt." Most of the material is mounted on slides, but specimens in Felt's collection that are on cardpoint or in alcohol are indicated as such.

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The writer wishes to express his appreciation to Dr. R. D. Glasgow and Dr. C. C. Adams for the privilege of studying the Felt collection in the New York State Museum; to Mr. C. F. W. Muesebeck and Dr. E. A. Chapin for the many courtesies extended for studying the types in the U.S. National Museum, and to Dr. H. H. Ross for permission to study the Malloch types in the Illinois Natural History Survey collection. Through the kindness of Mr. Paul Freeman of the British Museum (Natural History), representatives were obtained of several species that occur in Europe and that were determined by Edwards. Miss M. M. Carpenter was of considerable aid in locating literature in the Washington libraries. Dr. D. G. Denning, Dr. H. K. Knutson, Dr. W. W. Wirth, Dr. H. P. Pratt, Dr. H. T. Peters, Dr. H. P. Nicholson, and Mr. A. W. Buzicky, all made a special effort to collect material for this study.

Subfamily LESTREMIINAE Rondani

Lestreminae Rondani, 1840, Sopra. Alc. Gen. Inset. Ditt., Mem. Sec. Serv. Ditt. Ital. (review in Isis von Oken, 1844: 450); Rondani, 1841, Prog. Classif. Fam. Inset. Ditt. Eur., Mem. Terza Serv. Ditt. Ital. (review in Isis von Oken, 1843: 617); Rondani, 1846, Nuov. Ann. Sci. Nat. Bologna ser. 2) 6:367; Rondani, 1847, Nuov. Ann. Sci. Nat. Bologna (ser. 2), 7:21; Schiner, 1864, Fauna Austr., Flieg., 2: xix; Schiner, 1868, Reise Öster-Freg. Nov., 2 (Zool. Theil, Abt. 1B, Dipt.): 5; Winnertz, 1870, Verh. zool.-bot. Ges. Wien, 20:9; Bergenstamm and Löw, 1877, Verh. zool.-bot. Ges. Wien, 26:17; van der Wulp, 1889, Dipt. Neerl., p. 45; Theobald, 1892, Acc. Brit. Flies, 3:86; Kieffer, 1898, Bull. Soc. Hist. Nat. Metz (ser. 2), 8:47; Kieffer, 1900, Ann. Soc. Ent. France, 69:450; Williston, 1908, Man. Dipt. N. Amer., 3d edit., pp. 127, 130; Kieffer, 1913, Gen. Insect., 152:284.

Lestremina Skuse, 1889, Proc. Linn. Soc. N. S. Wales, 3:133.

Lestremiinae Felt, 1908, Bull. N.Y. State Mus., 124:308; Felt, 1911, Jour. N.Y. Ent. Soc., 19:31; Enderlein, 1911, Arch. Naturg., 77 (Bd. 1, Suppl. 3): 187; Felt, 1913, Bull. N.Y. State Mus., 165:127; Felt, 1918, Philip. Jour. Sci., 13 (ser. D): 296; Felt, 1925, Bull. N.Y. State Mus., 257:136; Felt, 1929, Lignan Sci. Jour., 7:425; Mani, 1934, Rec. Ind. Mus., 36:378; Edwards, 1938, Proc. Roy. Ent. Soc. Lond., 7 (ser. B): 18; Mani, 1946, Indian Jour. Ent., 7:190.

Anaretina Loew, 1862, Mon. Dipt. N. Amer., 1:7; Osten Sacken, 1862, Mon. Dipt. N. Amer., 1:177.

The subfamily Lestremiinae differs from all other groups of the Itonididae in having the tarsus five-segmented with the basitarsus longer than the second segment. The larvae may be differentiated from the other groups, as far as is known at the present time, by having a simple, terminal anal tube.

A number of lestremiine midges have been reared from mushrooms, decaying wood and leaves, manure, moss, and from the soil. It is doubtful that any species feeds on living tissues of higher plants, although larvae have sometimes been found near plant roots or have sometimes been reared otherwise in connection with plants.

Lithomyza condita Scudder, a fossil fly from the tertiary deposits in Colorado, was referred to the Lestremiinae. The wing venation of this species, as described and figured by Scudder, is quite different from that of any known recent genera and appears to have more in common with the sciarids. Tibial spurs, however, were said to be absent.

KEY TO TRIBES

1. Apterous or brachypterous 2
   Alate 3
2. Ocelli two; sclerotized spermathecae absent .... *Lestremiini*
   Ocelli three; sclerotized spermathecae present .... *Micromyini*
3. M_{1+2} forked; CuP free, sometimes short; Sc_2 present, sometimes faint 4
   M_{1+2} simple; CuP fused with Cu; Sc_2 absent; ♀ usually with sclerotized spermathecae 6
4. M_{3+4} free; flagellar segments each with a proximal whorl of long bristles 5
   M_{3+4} arising from M; flagellum with the longer bristles scattered irregularly; h present; Pl present; ocelli three .... *Catotrichini*
5. Ocelli two or none; medial fork longer than stem; ♀ without sclerotized spermathecae; h present; Pl present .... *Lestremiini*
   Ocelli three; medial fork shorter than stem; ♀ with sclerotized spermathecae; h absent; Pl absent .... *Catochini*
6. M_{3+4} present, free; Cu_1 absent .... *Strobliellini*
   M_{3+4} absent; Cu_1 present, arising from Cu .... *Micromyini*

Tribe Lestremiini Kieffer

Lestremides Kieffer, 1898, Bull. Soc. Hist. Nat. Metz. (ser. 2), 8:52.

Lestremiariae Kieffer, 1900, Ann. Soc. Ent. France, 69:451; Kieffer, 1913, Gen. Insect., 152:305.

Lestremiinariae Felt, 1908, Bull. N.Y. State Mus., 124:308; Felt, 1913, Bull. N.Y. State Mus., 165:129; Felt, 1918, Philip. Jour. Sci., 13 (ser. D):296; Felt, 1925, Bull. N.Y. State Mus., 257:136; Felt, 1929, Lignan Sci. Jour., 7:425; Mani, 1934, Rec. Ind. Mus., 36:378; Mani, 1946, Ind. Jour. Ent., 7:191.

Lestreminariae Felt, 1911, Jour. N.Y. Ent. Soc., 19:31.

Lestremiini Enderlein, 1911, Arch. Naturg., 77 (Bd. 1, Suppl. 3):189; Enderlein, 1912, Zool. Anz., 40:263; Edwards, 1938, Proc. Roy. Ent. Soc. Lond., 7 (ser. B):24.

Lestremiinae Enderlein, 1936, Tierw. Mitteur., 6 (Lief 2, Teil 3):59.

The tribe Lestremiini may be recognized by having veins M_1 and M_2 present and longer than M_{1+2}; vein M_{3+4} present but obsolete proximally; ocelli two in number or absent; and sclerotized spermathecae absent (a single, large, membranous spermatheca has been noted in the genera *Lestremia* and *Anarete*).

The taxonomic views adopted in the present revision differ considerably from those of Felt, and a reference index, with the proposed synonymies and new combinations, is here given to facilitate a comparison of the species described by him. The names of Felt's species are listed with the combinations used by him in his 1913 revision or later, and their equivalents in the present revision are given in a corresponding list. The species described by Malloch and Cockerell are also included, so that the list is complete for the species previously described from North America.

Species Previously Described from North America	Equivalents in Present Classification
Lestremia acerifolia (Felt)	*Anaretella defecta* (Winnertz)
barberi Felt	*Allarete barberi* (Felt)
dyari Felt	*Lestremia cinerea* Macquart
elongata Felt	*Pararete elongata* (Felt)
floridana Felt	*Lestremia cinerea* Macquart
franconiae Felt	*Lestremia cinerea* Macquart
garretti Felt	*Lestremia cinerea* Macquart
kansensis Felt	*Lestremia cinerea* Macquart
occidentalis Felt	*Lestremia leucophaea* (Meigen)
pini Felt	*Anaretella defecta* (Winnertz)
sambuci (Felt)	*Lestremia leucophaea* (Meigen)
setosa Felt	*Lestremia leucophaea* (Meigen)
solidaginis (Felt)	*Lestremia solidaginis* (Felt)
spiraeina (Felt)	*Anaretella spiraeina* (Felt)
sylvestris (Felt)	*Lestremia cinerea* Macquart
vernalis Felt	*Allarete vernalis* (Felt)
Microcerata aldrichii Felt	*Anarete johnsoni* (Felt)
borealis Felt	*Anarete corni* (Felt)
buscki Felt	*Anarete buscki* (Felt)
cockerelli Felt	*Anarete johnsoni* (Felt)
corni (Felt)	*Anarete corni* (Felt)
diervillae (Felt)	*Anarete diervillae* (Felt)
iridis Cockerell	*Anarete johnsoni* (Felt)
johnsoni Felt	*Anarete johnsoni* (Felt)
perplexa Felt	*Anarete corni* (Felt)
spinosa Felt	*Anarete johnsoni* (Felt)
texana Felt	*Conarete texana* (Felt)
Neptunimyia tridens Felt	*Anaretella defecta* (Winnertz)
Zygoneura fenestrata Malloch	*Lestremia cinerea* Macquart

KEY TO GENERA

Males

1. Antenna with reduced number of segments, ranging from 10 to 12 2
   Antenna with 16 segments, the flagellar segments with long stems 3
2. Flagellar segments without distinct stems and without crenulate whorls; tegmen with roots extending anteriorly .... *Anarete* Haliday
   Flagellar segments with short stems, especially on distal segments, and each segment with a crenulate whorl of long bristles; tegmen with roots extending laterally .... *Conarete*, n. gen.
3. Flagellar segments each with a single crenulate whorl 4
   Flagellar segments each with two well-developed crenulate whorls 6
4. Eye bridge with a wide median portion devoid of facets; flagellar segments with bladelike sensorial processes .... *Wasmaniella* Kieffer
   Eye bridge two to three facets wide medially; flagellar segments with only sensorial spines ... 5
5. R_1 extending well beyond level of end of M_{3+4}; distiforceps short and stout, with a strong, angulate lobe above; genital rod with two divergent, anteriorly directed rods at distal end; flagellar stems with annulations .... *Gongromastix* Enderlein
   R_1 ending just proximal to level of end of Cu; distiforceps slender, without lobe; genital rod simple distally; flagellar stems without annulations .... *Allarete*, n. gen.
6. Flagellar segments with digitate sensorial processes; M_{3+4} with proximal end beyond level of r-m; tegmen broad; root of basiforceps directed anteriorly .... *Anaretella* Enderlein
   Flagellar segments with sensory spines only; M_{3+4} arising proximally before level of r-m; tegmen very narrow on distal portion; root of basiforceps directed inward .. *Lestremia* Macquart

FEMALES

1. Flagellum with sensorial processes....................2
   Flagellum with only sensory spines....................3
2. Apterous; eye bridge widely devoid of facets medially; sensorial processes of flagellum bladelike, sometimes bifid distally.................... *Wasmaniella* Kieffer
   Alate; eye bridge about two facets wide medially; sensorial processes strongly digitate *Anaretella* Kieffer
3. Front legs with proximal segments of tarsus provided with a sole of dense, short bristles *Conarete*, n. gen.
   Front legs with tarsus lacking a sole of dense bristles....................4
4. Medial fork gradually divergent from base; flagellum usually eight-segmented, rarely with a small ninth segment.................... *Anarete* Haliday
   Medial fork not divergent medially; flagellum nine-segmented, the ninth segment with a terminal nipple....................5
5. Flagellar segments slender, parallel-sided, with differentiated distal stems. *Lestremia* Macquart
   Flagellar segments obovate, with distal stems poorly differentiated....................6
6. Lamella of ovipositor with penultimate segment long and slender, twice length of terminal segment; medial fork infuscated and bearing sparsely placed setae........ *Pararete*, n. gen.
   Lamella of ovipositor with both segments about equal in length; medial fork not infuscated and bearing closely set, well-differentiated setae.................... *Allarete*, n. gen.

Neolestremia Mani (1934) was based on a single species, *N. boerhaviae* Mani, which is known from a single ♀ from India. This ♀ was described as having sixteen antennal segments, although Mani later (1946) indicated that only eleven segments are present. The genus was differentiated from *Lestremia* on a basis of having only three palpal segments.

A ♀ collected by the writer at Atlantic Beach, Florida, agrees with Mani's description of *Neolcstremia* in having the palpus three-segmented, the flagellar segments with long enlargements and uniformly covered with short setae, and the proximal segment of the ovipositor short and broad. The flagellum of the Florida ♀ is nine-segmented, with the terminal segment elongate-elliptical; the setae are all acute, rather densely scattered over the enlargement, and only segments two, three, and four show a sparse proximal whorl of short bristles. The ocelli are present; the eye bridge is two facets wide medially; the fore tarsus bears short, stout, rather sparsely set setae ventrally; and the wing venation is similar to *Conarete*.

Four ♀♀ collected at May Pen, Jamaica, by the writer agree with *Neolestremia* in having the palpus three-segmented, the flagellar segments with long enlargements, and the proximal segment of the ovipositor short and broad. The flagellum contains nine segments, each with a proximal whorl of long bristles and the terminal segment constricted predistally and with another whorl of long bristles near the tip. Shorter, acute setae are found distally on the enlargements as well as a few awllike sensorial processes that may be bifid on proximal segments. Ocelli are absent; the eye bridge is three facets wide medially; the fore tarsus bears a sole of short, stout bristles; and the wing venation is similar to *Conarete*.

Lestremia Macquart

Lestremia Macquart, 1826, Insect. Dipt. Nord. France, part 1, Tipul., p. 173; Meigen, 1830, Syst. Beschr. bekann. europ. zweifl. Insekt., 6:308; Macquart, 1834, Hist. Nat. Insect., 1:157; West-

wood, 1840, Introd. Classif. Insects, Syn. Gen., p. 127; Walker, 1856, Insect. Brit., Dipt., 3:57; Schiner, 1864, Fauna Austr., Flieg., 2:413; Winnertz, 1870, Verh. zool.-bot. Ges. Wien, 20:35; van der Wulp, 1877, Dipt. Neerl., p. 80; Skuse, 1889, Proc. Linn. Soc. N. S. Wales, 3:144; Kieffer, 1898, Bull. Soc. Hist. Nat. Metz (ser. 2), 8:52; Kieffer, 1900, Bull. Soc. Ent. France, 69:437; Felt, 1908, Bull. N.Y. State Mus., 124:310; Felt, 1911, Jour. N.Y. Ent. Soc., 19:31; Enderlein, 1911, Arch. Naturg., 77 (Bd. 1, Suppl. 3):191; Felt, 1913, Bull. N.Y. State Mus., 165:129; Kieffer, 1913, Gen. Insect., 152:307; Edwards, 1929, Ent. Mo. Mag., 65:11; Mani, 1934, Rec. Ind. Mus., 36:379; Edwards, 1938, Proc. Roy. Ent. Soc. Lond., 7 (ser. B):25.

Lestremia (*Cecidogona*) Loew, 1844, Ent. Zeitschr. ent. Ver. Stettin, 5:324; Winnertz, 1870, Verh. zool.-bot. Ges. Wien, 20:35.

Cecidogona Loew: Walker, 1856, Insect. Brit., Dipt., 3:58; Loew, 1862, Monog. N. Amer. Dipt., 1:7; Skuse, 1889, Proc. Linn. Soc. N. S. Wales, 3:144; Kieffer, 1900, Bull. Soc. Ent. France, 69:443.

Type of genus.—Monobasic, *Lestremia cinerea* Macquart.

Type of generic synonym.—*Cecidogona:* Monobasic [*Lestremia* (*Cecidogona*) *carnea* Loew] = *Lestremia carnea* Loew.

Cecidogona Loew was differentiated from *Lestremia* on the basis of a sexually dimorphic character, the fewer number of antennal segments in the ♀. The description of the wing venation indicates that R_s is distinct, and the antennal segments were described as "egg-shaped," each a little slenderer than the preceding and very indistinctly "necked." This description is more applicable to *Anaretella* than to *Lestremia.* It seems more conducive to nomenclatural stability, however, to follow Edwards in considering *Cecidogona* a synonym of *Lestremia,* because the genotype has never been identified.

Two species of *Lestremia* are known to occur in Great Britain, and both of these are of widespread occurrence in the United States and Canada. A third North American species is known from the eastern United States.

Lestremia cinerea was reared by C. N. Ainslie from larvae on wheat roots in Iowa, by H. M. Barnes (1946) from mushrooms in England, and by the writer from moldy but living grass roots in California. Kieffer stated that *L. leucophaea* larvae were found in decaying beech wood, but the identification is open to question. A ♀ belonging to the genus *Lestremia* was reared from diseased elm in Oxfordshire, England.

KEY TO NORTH AMERICAN SPECIES

Males

1. Distiforceps with a spine distally; tenth tergite extending well beyond basiforceps..........2
   Distiforceps with two teeth distally; tenth tergite extending approximately to end of basiforceps *cinerea* Macquart
2. Basiforceps with a setose proximoventral lobe inside; tenth sternite broadly rounded; ninth tergite with caudal margin distinctly angulate........................*solidaginis* (Felt)
   Basiforceps without proximoventral lobe; tenth sternite not obviously rounded; ninth tergite with caudal margin broadly rounded...............................*leucophaea* (Meigen)

Lestremia cinerea Macquart

Lestremia cinerea Macquart, 1826, Insect. Dipt. Nord. France. pt. 1, Tipul., p. 173, Macquart, 1834, Hist. Nat. Insect., 1:157 (fig. wing); Edwards, 1929, Ent. Mo. Mag., 65:12; Edwards, 1938, Proc. Roy. Ent. Soc. Lond., 7 (ser. B):25 (fig. wing, ♂ genitalia, ♀ antenna).

Lestremia fusca Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:309; Edwards, 1929,

Ent. Mo. Mag., 65:12; Edwards, 1938, Proc. Roy. Ent. Soc. Lond., 7 (ser. B):27 (fig. wing). New synonymy.

Lestremia ?fusca Meigen: Winnertz, 1870, Verh. zool.-bot. Ges. Wien, 20:33.

Catocha sylvestris Felt, 1907, Bull. N.Y. State Mus., 110:102. New synonymy.

Lestremia sylvestris (Felt): Felt, 1908, Bull. N.Y. State Mus., 124:311; Felt, 1913, Bull. N.Y. State Mus., 165:136 (fig. ♀ palpus and antennal segment; photogr. wing).

Lestremia kansensis Felt, 1908, Bull. N.Y. State Mus., 124:311; Felt, 1913, Bull. N.Y. State Mus., 165:137. New synonymy.

Lestremia franconiae Felt, 1908, Bull. N.Y. State Mus., 124:311; Felt, 1913, Bull. N.Y. State Mus., 165:141. New synonymy.

Lestremia dyari Felt, 1908, Bull. N.Y. State Mus., 124:311; Felt, 1913, Bull. N.Y. State Mus., 165:141. New synonymy.

Zygoneura fenestrata Malloch, 1914, Bull. Ill. State Lab. Nat. Hist., 10:233 (fig. wing, ♂ terminalia, ovipositor, and distal antennal segment of ♀); Frison, 1927, Bull. Ill. Nat. Hist. Survey, 16:180; Edwards, 1938, Proc. Roy. Ent. Soc. Lond., 7 (ser. B):25. New synonymy.

Lestremia floridana Felt, 1915, Canad. Ent., 47:226. New synonymy.

Lestremia garretti Felt, 1926, Canad. Ent., 58:265. New synonymy.

Edwards proposed to fix Macquart's name to this species. The identification is probably correct, and there is no way to disprove it. Edwards has adequately figured and described *L. cinerea*, and some of his material has been examined by the writer. The two teeth on the distiforceps are distinctive.

L. franconiae Felt and *L. dyari* Felt were each based on a single ♂. The genitalia of these two ♂♂ are identical. *Dyari* was considered distinct from *franconiae* due to the slightly longer stems of the flagellar segments of the former. The stems of the middle flagellar segments in *franconiae* appear to be about the same length as the proximal enlargements, although the antennae are crumpled. In *dyari* the stems of the middle flagellar segments are slightly but distinctly longer than the proximal enlargements. In the long series on hand, specimens from the western United States tend to have the longer flagellar stems, but variation in this character is evident. The mounted paratype ♂ of *Zygoneura fenestrata* Malloch agrees entirely with *cinerea*.

The ♀ of *cinerea*, based on field association of adults in a number of instances and also on reared material, is characterized by having the second palpal segment without a distolateral projection and by having the stem of the third flagellar stem, between the proximal enlargement and the small distal node, broader than long (fig. C, 18). There is some variation in the lengths of the flagellar stems, however; and the stems of the segments beyond the middle of the flagellum may be wider than long, about the same width as length, or slightly longer than wide. The monotype ♀♀ of *kansensis* and *floridana*, as well as the paratype ♀ of *fenestrata*, have the short flagellar stems, whereas the monotype ♀♀ of *sylvestris* and *garretti* have somewhat longer flagellar stems. Felt stated that *floridana* was distinct from *kansensis* because of the longer and slenderer terminal antennal segment of the former. The terminal nipple in either case is long, but it is longer in *kansensis*. This nipple is subject to considerable variation in length.

It seems best to accept as correct Winnertz's determination of *fusca* as described and figured by Edwards, even though Winnertz himself questioned it. Edwards listed *fusca* as a distinct species but stated that it might be only a smaller, darker form of *cinerea*, differing mostly in having the anal area of the wing more obtuse.

Fusca should be considered a synonym of *cinerea*. Of the five specimens reared by Ainslie, the anal angle is broadly obtuse in the smallest, bluntly right-angled in the largest, and is rather intermediate in the other specimens. No other differences were noted. This is good evidence that only a variation is under consideration.

Edwards considered *L. carnea* Loew and *L. declinata* Kieffer as probable synonyms of *cinerea*, but their identity cannot be established from the descriptions alone.

Type.—Lost.

Types of synonyms.—*Fusca:* lost; *sylvestris:* monotype ♀, at the New York State Museum; *kansensis:* monotype ♀, at the New York State Museum; *franconiae:* monotype ♂, at the U.S. National Museum; *dyari:* monotype ♂, at the U.S. National Museum; *fenestrata:* lectotype ♂ (on cardpoint), selected by Frison, 1927, at the Illinois Natural History Survey; *floridana:* monotype ♀, at the New York State Museum; *garretti:* monotype ♀, at the New York State Museum.

Specimens examined.—CALIFORNIA: 9 ♂♂, 21 ♀♀, Berkeley, Jan.–Apr., Oct., 1947, and Feb., 1950, A. E. Pritchard; 1 ♂, 1 ♀, Colma, May 26, 1947, A. E. Pritchard; 14 ♂♂, Niles, Nov. 19, 1947, W. W. Wirth; 5 ♂♂, Oakland, Oct. 26, 1947, W. W. Wirth; 1 ♂, Oakland, Jan. 11, 1948, A. E. Pritchard; 2 ♂♂, 14 ♀♀, Orinda, Feb.–Apr., 1947, A. E. Pritchard; 1 ♂, Richmond, Apr. 14, 1947, A. E. Pritchard; 4 ♂♂, Richmond, Dec. 28, 1947, W. W. Wirth; 1 ♀, Salida, Apr. 16, 1947, A. E. Pritchard; 6 ♂♂, 3 ♀♀, San Antonio Valley, Nov. 11, 1947, A. E. Pritchard; 37 ♂♂, 1 ♀, Walnut Creek, Apr. 6, 1947, A. E. Pritchard. FLORIDA: 1 ♀, Jacksonville (monotype of *floridana*); 1 ♂, New Smyrna, Dec. 5, 1941, H. D. Pratt. ILLINOIS: 1 ♂, 1 ♀, Urbana, Nov. 13, 1913, C. A. Hart and J. R. Malloch (paralectotype and lectoallotype of *fenestrata*). INDIANA: 2 ♂♂, 1 ♀, Lafayette, May 1, Aldrich, from winter wheat (undetermined by Felt). IOWA: 2 ♂♂, 3 ♀♀, Moravia, July 14, 1915, C. N. Ainslie (undetermined by Felt). KANSAS: 1 ♀, Douglas Co., May, E. S. Tucker (monotype of *kansensis*). MINNESOTA: 1 ♀, Anoka, Sept. 3, 1941, A. E. Pritchard; 42 ♂♂, 5 ♀♀, Appleton, June 19, 1941, A. E. Pritchard; 1 ♀, Baudette, Oct. 8, 1941, D. G. Denning; 2 ♀♀, Brownsville, May 29–30, 1941, A. E. Pritchard; 2 ♂♂, Campbell, Oct. 15, 1941, D. G. Denning; 2 ♂♂, Detroit Lakes, June 20, 1941, A. E. Pritchard; 1 ♀, Fort Snelling, Apr. 18, 1941, A. E. Pritchard; 2 ♂♂, 3 ♀♀, Gray Eagle, Oct. 18, 1941, D. G. Denning; 2 ♀♀, Shelley, July 29, 1941, A. E. Pritchard; 3 ♂♂, St. Paul, May 9–12, A. E. Pritchard; 1 ♂, 5 ♀♀, St. Paul, Apr. 23–28, 1942, D. G. Denning; 10 ♂♂, Tenney, June 19, 1941, A. E. Pritchard. NEW HAMPSHIRE: 1 ♂. Mt. Washington (monotype of *franconiae*). NORTH CAROLINA: 1 ♀, Davidson's River, Sept. 23, 1906 (monotype of *sylvestris*). NORTH DAKOTA: 1 ♀, Fargo, July 28, 1941, A. E. Pritchard. RHODE ISLAND: 1 ♂, Kingston, July 20, 1905 (undetermined by Felt). SOUTH DAKOTA: 1 ♀, Elk Point, Apr. 22, 1915, swept from winter wheat (undetermined by Felt). TEXAS: 1 ♀, Plano, May, 1907, at dusk in oat field (undetermined by Felt). WASHINGTON: 1 ♂, Seattle, June 18, 1948, D. G. Denning. WISCONSIN: 16 ♂♂, 2 ♀♀, Elmwood, May 17, 1942, D. G. Denning. BRITISH COLUMBIA: 1 ♂, Kaslo, July 6 (not June 7), Dyar (monotype of *dyari*); 1 ♀, Michel, Aug. 15, C. Garrett (monotype of *garretti*). ENGLAND: 1 ♂, 1 ♀, Letchworth, Herts, Feb., 1918, F. W. Edwards.

Lestremia leucophaea (Meigen)

Sciara leucophaea Meigen, 1818, Syst. Beschr. bekann. eur. zweifl. Inskt., 1:288.

Lestremia leucophaea (Meigen): Macquart, 1834, Hist. Nat. Insect., 1:158; Winnertz, 1870, Verh. zool.-bot. Ges. Wien, 20:31; Edwards, 1928, Insect. Samoa, 6:40; Edwards, 1929, Ent. Mo. Mag., 65:12; Edwards, 1938, Proc. Roy. Ent. Soc. Lond., (ser. B):27 (fig. wing, ♂ genitalia).

Catocha sambuci Felt, 1907, Bull. N.Y. State Mus., 110:101. New synonymy.

Lestremia sambuci (Felt): Felt, 1908, Bull. N.Y. State Mus., 124:311; Felt, 1913, Bull. N.Y. State Mus., 165:136.

Lestremia setosa Felt, 1908, Bull. N.Y. State Mus., 124:311; Felt, 1913, Bull. N.Y. State Mus., 165:140. New synonymy.

Lestremia occidentalis Felt, 1926, Canad. Ent., 58:265. New synonymy.

Edwards proposed to accept Winnertz's identification of *leucophaea* as the true *leucophaea* of Meigen, and this proposal should be accepted. Winnertz's identification was aided by a figure of the wing that Meigen had sent him. In *leucophaea* the lower branch of the medial fork typically forms a straight line with the stem. It is difficult to appreciate this venational character as a rule, however, for the recognition of the species.

The ♂ genitalia of *leucophaea* are distinctive and have been adequately figured by Edwards. The ninth tergite is broadly rounded caudally; the basiforceps bear no lobe and the distiforceps bear a spine distally; the tenth tergite is very long, and the setose areas of the tenth sternite are nearly parallel. The genitalia of the monotype ♂ of *setosa* are essentially identical with other ♂♂ from North America and with the figure presented by Edwards. The lobes of the tenth tergite are more approximate and broader in the *setosa* ♂, apparently because they are more flattened out; and the roots of the basiforceps are somewhat slenderer in the *setosa* ♂, probably due to orientation.

The ♀, as identified by the writer, can be recognized by the long stems of the flagellar segments (fig. C, 17). The stem of the third segment has the portion between the proximal enlargement and the small distal node distinctly longer than broad, and this portion is about twice as long as broad on segments beyond the middle. The flagellar bristles, aside from the proximal whorl, are in large part sparser and longer than in *cinerea*. The second segment of the palpus does not bear a distolateral projection. The monotype ♀♀ of *sambuci* and *occidentalis* agree in regard to those characters. Felt did not state why he considered *occidentalis* to be different from other species.

Type.—Lost.

Types of synonyms.—*Sambuci:* monotype ♀, at the New York State Museum; *setosa:* monotype ♂, at the New York State Museum; *occidentalis:* monotype ♀, at the New York State Museum.

Specimens examined.—MINNESOTA: 1 ♀, Anoka, June 15, 1941, A. E. Pritchard; 1 ♂, Grand Marais, Aug. 2, 1941, A. E. Pritchard; 1 ♂, Howard Lake, July 28, 1941, A. E. Pritchard; 1 ♂, St. Paul, July 19, 1941, A. E. Pritchard; 4 ♂♂, 2 ♀♀, Wayzata, May 16, 1942, A. E. Pritchard. NEW YORK: 1 ♂, Albany, July 22 (not 24), 1906 (monotype of *setosa*); 1 ♀, Albany, Aug. 6, 1906 (monotype of *sambuci*); 1 ♀, Mt. Orrey (determined by Felt as *sylvestris*). WASHINGTON: 1 ♀, American River, June 10, 1948, A. E. Pritchard. BRITISH COLUMBIA: 1 ♀, Cranbrook, Aug. 22, 1920 (monotype of *occidentalis*); 1 ♀, Cranbrook, Aug. 22, 1920 (determined as ?*occidentalis* by Felt).

Lestremia solidaginis (Felt)

Catocha solidaginis Felt, 1907, Bull. N.Y. State Mus., 110:102.

Lestremia solidaginis (Felt): Felt, 1908, Bull. N.Y. State Mus., 124:311; Felt, 1913, Bull. N.Y. State Mus., 165:139.

L. solidaginis is very similar to *cinerea* and *leucophaea*, but the ♂ genitalia are distinctive (fig. B, 12). These genitalia are characterized by having the basiforceps provided with a rather large, setose lobe on the inside proximoventrally. The ninth tergite is distinctly angulate on the caudal margin; the terminal spine on the distiforceps is turned inward; the tenth tergite is very long, and the tenth sternite is considerably shorter than the tergite and is broadly rounded.

The ♀ here ascribed to *solidaginis*, on a basis of field association and palpal characters, may be recognized by having a distinct angulate projection on the

inner, distal end of the second palp segment (fig. C, 24). The stems of the flagellar segments are rather intermediate in length between that of *cinerea* and *leucophaea.* The stems of the segments beyond the middle of the flagellum have the portion between the proximal enlargement and the small distal node about equal in length and width or slightly longer. Many of the flagellar sensory bristles appear to be slenderer and more pointed than in *cinerea.*

Monotype.—♂, at the New York State Museum (it is the only specimen labeled as type, and it is the only slide numbered C700, which was indicated originally as the type number).

Specimens examined.—MINNESOTA: 6 ♂♂, 4 ♀♀, Afton, May 10, 1941. A. E. Pritchard; 2 ♀♀, Anoka, June 15, 1941, A. E. Pritchard; 3 ♂♂, Detroit Lakes, June 20, 1941, A. E. Pritchard; 1 ♂, Stillwater, Sept. 6, 1941, A. E. Pritchard; 1 ♀, Tenney, June 19, 1941, A. E. Pritchard; 1 ♀, Two Harbors, Aug. 2, 1941, A. E. Pritchard. NEW YORK: 1 ♂, Newport, July 25, 1906 (monotype of *solidaginis*); 2 ♂♂, Newport, July 20 and 25, 1906 (determined by Felt as *solidaginis*); 1 ♂, Albany, July 11, 1906 (determined by Felt as *solidaginis*). WISCONSIN: 1 ♀, Elmwood, May 17, 1942, D. G. Denning.

Anaretella Enderlein

Anaretella Enderlein, 1911, Arch. Naturg., 77 (Bd. 1, Suppl. 3):193; Enderlein, 1936, Tierw. Mitteleur., 6 (Lief 2, Teil 3):59.

Lestremia (*Anaretella*) Enderlein: Edwards, 1929, Ent. Mo. Mag., 65:13; Edwards, 1938, Proc. Roy. Ent. Soc. Lond., 7 (ser. B):27.

Neptunimyia Felt, 1912, Jour. N.Y. Ent. Soc., 20:237; Felt, 1913, Bull. N.Y. State Mus., 165:150; Kieffer, 1913, Gen. Insect., 152:309.

Plocimas Enderlein, 1936, Tierw. Mitteleur., 6 (Lief 2, Teil 3):59. New synonymy.

Type of genus.—By original designation, *Lestremia defecta* Winnertz.

Types of generic synonyms.—*Neptunimyia:* monobasic and by original designation (*Neptunimyia tridens* Felt) = *Anaretella defecta* (Winnertz); *Plocimas:* monobasic, *Plocimas hirsutus* Enderlein (probably a synonym of *A. defecta*).

Anaretella Enderlein was originally based on an inaccurate drawing of the wing of *Lestremia defecta* Winnertz that accompanied the original description. The description clearly indicates that the drawing is wrong; and in further confirmation of this, Edwards examined a ♂ in Winnertz's collection. Enderlein later erected *Plocimas* for an actual specimen (a ♂ from Winnertz in H. Loew's collection), still retaining *Anaretella* on a basis of the misleading drawing. *Neptunimyia* was based on the sensorial processes of the ♀ antenna, without reference to *Anaretella.*

Edwards considered *Anaretella* as worthy of only a subgenus of *Lestremia,* since *A. africana* Enderlein was somewhat intermediate between the two. *Africana,* however, probably belongs to another group of species that is considered worthy of generic rank in this paper.

The genus *Anaretella* includes two species that occur both in North America and Europe and a third species that is here described from the northwestern United States. One other species has been recognized from Samoa, on the basis of a single ♀.

KEY TO NORTH AMERICAN SPECIES

MALES

1. Distiforceps tapering distally, with two small cusps at tip; tegmen angulate at distal end, bearing two small projections at tip above; basiforceps without narrow lobe.............2

   Distiforceps broadly expanded distally, forming broad dorsal and ventral angulations; tegmen with strong, diverging arms distally; basiforceps with narrow lobe on inside medioventrally *iola,* n.sp.

2. **Basiforceps with a setose enlargement inside near the distal end; tegmen produced caudoventrally into a narrow point...*spiraeina* (Felt)**
Basiforceps without setose enlargement; tegmen broadly angulate caudoventrally *defecta* **(Winnertz)**

Anaretella defecta (Winnertz)

Lestremia defecta **Winnertz, 1870, Verh. zool.-bot. Ges. Wien, 20:33 (fig. wing).**
Anaretella defecta **(Winnertz): Enderlein, 1911, Arch. Naturg., 77 (Bd. 1, Suppl. 3): 193; Enderlein, 1936, Tierw. Mitteleur., 6 (Lief 2, Teil 3): 59 (fig. wing).**
Lestremia (Anaretella) defecta **Winnertz: Edwards, 1929, Ent. Mo. Mag., 65: 13; Edwards, 1938, Proc. Roy. Ent. Soc. Lond., 7 (ser. B): 27 (fig. wing, palpus, distal segments of ♂ and ♀ antennae, ♂ genitalia).**
Campylomyza acerifolia **Felt, 1907, Bull. N.Y. State Mus., 110:101. New synonymy.**
Lestremia acerifolia **(Felt): Felt, 1908, Bull. N.Y. State Mus., 124:311; Felt, 1913, Bull. N.Y. State Mus., 165: 139.**
Lestremia pini **Felt, 1907, Bull. N.Y. State Mus., 110:103; Felt, 1913, Bull. N.Y. State Mus., 165:138 (fig. ♂ antennal segment). New synonymy.**
Neptunimyia tridens **Felt, 1912, Jour. N.Y. Ent. Soc., 20:237; Felt, 1913, Bull. N.Y. State Mus., 165:150 (fig. ♀ antennal segment and palpus). New synonymy.**
Neptunimyia bromleyi **Barnes, 1928, Entomologist, 61:173 (fig. head, claws, wing, and ♂ genitalia).**

The ♂ genitalia of *defecta* are distinctive, and they have been adequately figured by Edwards. The basiforceps are without lobes, and the distiforceps taper distally and bear two inconspicuous cusps terminally; the tegmen is angulate distally, being produced into a narrow point caudoventrally and bearing two small projections caudodorsally.

The monotype ♂♂ of *pini* and *acerifolia* are identical and must be considered synonyms of *defecta*. A ♂ collected in England and determined by Edwards has been compared with North American material.

The lectotype ♀ of *tridens* agrees in all respects with ♀♀ taken in association with *defecta* ♂♂ in North America and with a ♀ from England that was determined by Edwards. It should be pointed out that ♀♀ of other nearctic species of *Anaretella* have not been recognized and that the ♀ of *spiraeina* may be very similar to that of *defecta.*

Type.—A ♂ that can be considered type, in Winnertz's collection at Bonn.

Types of synonyms.—*Acerifolia:* monotype ♂, in the New York State Museum; *pini:* monotype ♂, in the New York State Museum; *tridens:* lectotype ♀, by present designation (on two slides, the paralectotype on cardpoint) in the New York State Museum; *bromleyi:* type ♀, in Barnes's collection at Rothamsted.

Specimens examined.—CALIFORNIA: 2 ♂♂, 2 ♀♀, Orinda, Feb. 2, 1947, A. E. Pritchard. MINNESOTA: 4 ♂♂, 2 ♀♀, Afton, May 10, 1941, A. E. Pritchard. NEW YORK: 1 ♂, Albany, July 16, 1906 (monotype of *pini*); 1 ♂, Albany, May 21, 1906 (monotype of *acerifolia*); 2 ♀♀, Nassau, Apr. 17, 1911 (lectotype and paralectotype of *tridens*). WASHINGTON: 1 ♂, 2 ♀♀, American River, June 10, 1948, A. E. Pritchard; 1 ♂, Greenwater, June 18, 1948, A. E. Pritchard. WISCONSIN: 1 ♂, 2 ♀♀, Elmwood, May 17, 1942, D. G. Denning. ENGLAND: 1 ♂, Tomentoul, Banffshire, Aug. 8–11, 1937, R. L. and B. M. Coe; 1 ♀, Letchworth, Herts, May, 1918, F. W. Edwards.

Anaretella spiraeina (Felt), new combination

Catocha spiraeina **Felt, 1907, Bull. N.Y. State Mus., 110:102.**
Lestremia spiraeina **(Felt): Felt, 1908, Bull. N.Y. State Mus., 124:311; Felt, 1913, Bull. N.Y. State Mus., 165:140.**

Lestremia (*Anaretella*) *strobli* Edwards, 1938, Proc. Roy. Ent. Soc. Lond., 7 (ser. B): 27 (fig. wing, terminal antennal segments of ♂, and ♂ genitalia). New synonymy.

The hypopygium of *spiraeina* is similar to that of *defecta;* however, the basiforceps bear a strong setose enlargement on the inside predistally, and the tegmen is not produced into a narrow point caudoventrally.

The monotype ♂ of *spiraeina* is the same as that described and figured by Edwards as *strobli.* The length of the stems of the flagellar segments of the ♂ is somewhat variable, being longer in the larger specimens. The ♀ is unknown.

Monotype.—♂, at the New York State Museum.

Type of synonym.—*Strobli,* type ♂, at the British Museum (Natural History).

Specimens examined.—MINNESOTA: 1 ♂, Afton, May 10, 1941, A. E. Pritchard; 1 ♂, Bagley, July 30, 1941, A. E. Pritchard; 2 ♂♂, Wadena, July 2, 1941, A. E. Pritchard. NEW YORK: 1 ♂, Albany, June 15, 1906 (monotype of *spiraeina*). OREGON: 1 ♂, Oakridge, June 21, 1948, A. E. Pritchard. WASHINGTON: 2 ♂♂, American River, June 10, 1948, A. E. Pritchard; 1 ♂, North Bend, June 17, 1948, A. E. Pritchard.

Anaretella iola, n. sp.

Anaretella iola is considerably divergent from the other two members of the genus that are known from ♂♂, because of the development of two strongly sclerotized prongs caudally on the tegmen, the strong genital rod, the broad union of the basiforceps below, and the broadly expanded distiforceps. The ♀ is unknown.

Male.—Eye bridge about two facets wide medially. Flagellum (fig. C, 22) with stems about as long as the nodes, slightly longer on more distal segments; nodes each bearing two rings of crenulate setae and distally provided with several crenulations and several digitate sensorial processes. Palpus four-segmented, the third and fourth segments each slightly longer than the first and second combined. Wings (fig. A, 3) with R_5 extending well beyond level of end of M_{3+4}; R_s and r-m both very short, about equal in length. Hypopygium (fig. B, 9) with ninth tergite broadly rounded; tenth tergite a pair of small divergent lobes; basiforceps broadly united below, each bearing an elongate lobe inside and below; distiforceps strongly widened to form large dorsal and ventral angulations terminally; tegmen broad, with sclerotized, parallel, lateral margins, above bearing medially a long pair of strongly sclerotized, diverging, acuminate projections; genital rod heavily sclerotized, widened at distal end and with caudal margin concave. Length of wing, 3.2 mm.

Holotype.—♂, American River, Washington, June 10, 1948, A. E. Pritchard; in the writer's collection.

Paratype.—♂, American River, Washington, June 10, 1948, A. E. Pritchard.

Allarete, n. gen.

Type of genus.—*Lestremia vernalis* Felt.

The genus *Allarete* differs from *Lestremia, Anaretella, Gongromastix,* and *Wasmaniella* by having the lower branch of the medial fork as plain as the upper branch and neither infuscated; the setae on M, Cu, and A densely set and well differentiated; and r-m obliterated, much shorter than R_s.

Ocelli two. Eyes with short, wide bridge, about two facets wide medially. Antennal segments of ♂ 2 + 14; flagellar segments each with long stem, the enlargements with a proximal whorl of setae, a median crenulate whorl of very long bristles, with short and long bristles scattered distally, and sensory hairs largely clustered on either side. Antenna of ♀ 2 + 9; flagellar segments subelliptical, somewhat longer distally, practically lacking distal necks, each with a proximal whorl of bristles and otherwise covered with short bristles that are largely sensory; terminal

segment constricted near distal end and with longer bristles on terminal knob. Palpi four-segmented, the first with sensory bristles inside, the third and fourth long. Wings hyaline, covered with microchaetae and, less densely, with macrochaetae; C, R, and base of M pigmented and well differentiated from other veins; C and R with longer setae; costal cell wide and cell R_1 wide proximally; C ending abruptly at tip of R_5, terminating approximately at level of end of M_{3+4}; R_s short but distinct; r-m obliterated; M except proximal division, Cu, and A unpigmented, densely set with macrochaetae; fork of M 2 to 3½ times as long as its stem; M_{3+4} arising proximal to r-m. Claws with short teeth externally; empodium short and broad. Hypopygium with ninth tergite rather short; tenth tergite completely exserted, rather long, subdivided; basiforceps with root heavily pigmented, directed anteriorly; distiforceps stout, tapering, without distal spine; tegmen broad with strong ventral roots and narrow dorsal roots; genital rod long, slightly widened distally, with a hyaline cap. Ovipositor short; penultimate segment of lamellae short, rather broad, trapezoidal; ultimate segment slightly shorter, subovate.

A ♀ of *Allarete vernalis* was reared from cow manure at Dallas, Texas.

Besides the following species, the genus probably includes *Anaretella africana* Enderlein.

KEY TO NORTH AMERICAN SPECIES

1. Wings with medial fork twice length of stem.............................*vernalis* (Felt)
   Wings with medial fork three times length of stem........................*barberi* (Felt)

Allarete barberi (Felt), new combination

Lestremia barberi Felt, 1908, Bull. N.Y. State Mus., 124:310; Felt, 1913, Bull. N.Y. State Mus., 165:135.

A. barberi may be recognized by having the medial fork very long, about three times as long as its stem (fig. A, 7). This character is found elsewhere in the Lestremiini only among species in the genera *Anarete* and *Conarete*. The ♂ is unknown.

Monotype.—♀, in the U.S. National Museum.

Specimens examined.—CALIFORNIA: 6 ♀♀, Burney Falls, July 15, 1947, A. E. Pritchard, at light. MINNESOTA: 5 ♀♀, Wabasha, Aug. 15, 1941, H. T. Peters, light trap. NEW MEXICO: 1 ♀, Las Vegas, Aug. 18 (not 8), H. S. Barber (monotype of *barberi*).

Allarete vernalis (Felt), new combination

Lestremia vernalis Felt, 1908, Bull. N.Y. State Mus., 124:311; Felt, 1913, Bull. N.Y. State Mus., 165:142

Vernalis differs from *barberi* in having the medial fork comparatively short, about twice the length of the stem (fig. A, 5).

In the monotype ♂ of *vernalis,* the tegmen is subquadrate, twice as long as broad, with the caudal margin slightly convex and the caudolateral angles somewhat widened (fig. B, 13B). A ♂ from Minnesota has the tegmen appearing slenderer, slightly tapering, and with the caudal margin strongly convex (fig. B, 13A). No other differences were noted, and the Minnesota ♂ is referred to *vernalis* because it is possible that the apparent difference in the tegmen is owing to the fact that the genitalia of the monotype are strongly flattened.

Monotype.—♂, in the New York State Museum.

Specimens examined.—KANSAS: 1 ♂, Wichita, Apr., E. S. Tucker (monotype of *vernalis*). MINNESOTA: 1 ♂, Appleton, June 19, 1941, A. E. Pritchard. TEXAS: 1 ♀ (on cardpoint), Dallas, Sept. 12, 1907, F. C. Pratt, reared from cow manure.

Gongromastix Enderlein

Gongromastix Enderlein, 1936, Tierw. Mitteleur., 6 (Lief 2, Tiel 3):60; Edwards, 1938, Proc. Roy. Ent. Soc. Lond., 7 (ser. B):31.

Type of genus.—Monobasic, *Gongromastix andorrana* Enderlein.

Gongromastix resembles *Lestremia* and allied genera, but it may be distinguished by having cell R_1 very long and R_5 very long with its tip nearly reaching the level of the end of the lower branch of the medial fork. The distinct annulations on the long antennal stems of the ♂ are characteristic, as are the strong proximodorsal lobe of the distiforceps and the divergent, anteriorly directed rods at the distal end of the genital rod in the ♂ hypopygium.

The distribution of macrotrichia on the wing varies, possibly according to the species. The tenth tergite of the hypopygium is small, but it may lie underneath the ninth tergite or may be completely exserted. The ♀ is unknown.

The genus *Gongromastix* has been known only from a single ♂ from the Pyrenees representing *G. andorrana* Enderlein, which was inadequately described, and 2 ♂♂, one from Austria (type locality) and one from Spain, representing *G. angustipennis* (Strobl). Edwards (1938) has redescribed one of the ♂♂ representing *G. angustipennis*. Two very closely related species are here described from the United States.

KEY TO NORTH AMERICAN SPECIES

MALES

1. Wings with macrotrichia restricted to apical third; middle flagellar segments with stems 1½ times as long as proximal enlargements .... *schalis*, n. sp.
   Wings with macrotrichia covering entire surface; middle flagellar segments with stems twice as long as proximal enlargements .... *epista*, n. sp.

Gongromastix schalis, n. sp.

G. schalis differs from Edwards' description of *G. angustipennis* principally in that the tegmen distolaterally bears a series of small teeth, instead of two strong teeth, and the roots of the basiclasper are strongly widened. The tenth tergite lies beyond the ninth tergite, covering the distal portion of the tegmen rather than being concealed; the eye bridge is only about one facet wide medially; and both R_s and r-m are practically obliterated. The stems of the flagellar segments near the middle are about 1½ times as long as the proximal enlargements. The ♀ is unknown.

Male.—Eye bridge about one facet wide medially. Flagellum with stems of segments near the middle about 1½ times as long as enlargements, shorter on proximal and distal segments; enlargement with one crenulate whorl medially, with long bristles and short sensory hairs distally. Palpi four-segmented. Wings (fig. A, 2) with macrotrichiae confined to distal third; R_5 ending just before level of end of M_2; stem and base of medial fork without setae. Claws with fine teeth externally. Hypopygium (fig. B, 11) with ninth tergite having caudal margin slightly concave; tenth tergite beyond ninth, covering end of tegmen; basiforceps broadly united below, the roots with solid portion wider than longer; distiforceps short, with strong dorsal projection tapering to a short tooth; tegmen short and broad, narrowed on caudal half, broadly and truncately emarginate distally, the caudolateral margins having a ventral projection bearing short teeth. Length of wing, 2.3 mm.

Holotype.—♂, Anoka, Minnesota, June 15, 1941, A. E. Pritchard; in the writer's collection.
Paratype.—♂, Anoka, Minnesota, June 15, 1941, A. E. Pritchard.

Gongromastix epista, n. sp.

Epista differs from other members of the genus *Gongromastix* by having the macrotrichia of the wing scattered over the entire surface and by having the segments near the middle of the flagellum of the ♂ with the stems very long, about twice as long as the proximal enlargements. It is possible that additional material will show this species to be a synonym of *schalis*.

The hypopygium is similar to that of *schalis*, but the caudolateral angles of the tegmen each have a differentiated small tooth distally along with the series of smaller teeth on a ventral projection of the distolateral margin; the roots of the basiforceps are comparatively narrow as in *angustipennis*. The eye bridge is narrow medially as in *schalis;* and the tenth tergite is exserted as in *schalis*, being ventrally directed at the end of the ninth tergite. The wings have R_s obliterated, but r-m is distinctly developed, although short. The ♀ is unknown.

Holotype.—♂, American River, Washington, June 10, 1948, A. E. Pritchard; in the writer's collection.

Paratype.—♂, Cliffdell, Washington, June 10, 1948, A. E. Pritchard.

Pararete, n. gen.

Type of genus.—*Lestremia elongata* (Felt).

The genus *Pararete* differs from *Lestremia* and allied genera by the long penultimate segment of the ovipositor. The wing venation is similar to that of *Gongromastix* in that R_1 is very long, but R_s and r-m are both well developed and R_5 ends at a level just beyond the end of M_{3+4}. The closer relationships of *Pararete* can be shown when the ♂ is known.

Ocelli two. Eyes with short, wide bridge, two facets wide medially. Antennal segments of ♀ 2 + 9; flagellar segments subovate with scarcely evident neck distally, each with a proximal whorl of rather long bristles and with short bristles distally; the sensory bristles dense, largely confined to a distal pocket on either side of the flagellar segments; terminal segment with subterminal constriction forming a distal knob. Palpi four-segmented, the first elongate, densely set with sensory bristles inside, the third and fourth long. Wings wide, covered with dense microchaetae, uniformly but rather sparsely clothed with long macrotrichiae except near base of M and Cu; C, R, and M except basal division all covered with long setae; costal cell wide; R_1 long, at least ten times length of R_s; R_s short but distinct; r-m distinct, twice length of R_s; M with branches of fork evenly developed, although stem and base of fork not as plainly outlined; Cu_1 extending proximally well before r-m and distally reaching margin just before level of tip of R_5; M_{3+4} and Cu rather strongly outlined. Claws with fine teeth proximally; empodium broad, ½ as long as claws. Ovipositor with lamellae elongate, the penultimate segment twice as long as broad, the terminal segment elongate-oval, ½ as long as proximal segment and considerably narrowed.

Pararete elongata (Felt), new combination

Lestremia elongata Felt, 1908, Bull. N.Y. State Mus., 124:310; Felt, 1913, Bull. N.Y. State Mus., 165:135.

P. elongata is known from a single ♀.

Monotype.—♀, in the New York State Museum.

Specimens examined.—CALIFORNIA: 1 ♀, Argus Mountain, May, 1891, Albert Koebele (monotype of *elongata*).

Wasmaniella Kieffer

Wasmaniella Kieffer, 1898, Bull. Soc. Hist. Nat. Metz (ser. 2), 8:49; Kieffer, 1900, Ann. Ent. Soc. France, 69:245, 250, 252 (pl. 17, fig. 11); Enderlein, 1911, Arch. Naturg., 77 (Bd. 1, Suppl. 3):196; Felt, 1911, Jour. N.Y. Ent. Soc., 19:32; Felt, 1913, Bull. N.Y. State Mus., 165:155, Kieffer, 1913, Gen. Insect., 152:289; Pritchard, 1947, Ent. Amer., 27:10.

Type of genus.—Monobasic, *Wasmaniella aptera* Kieffer.

The genus *Wasmaniella* was established for a single species known only from a single apterous ♀ from Europe. An apterous ♀ from Minnesota is undoubtedly congeneric with the European species. Although Kieffer overlooked the short halteres and small empodia, the drawing he presented indicates that the structure of the eyes, the presence of ocelli, the shape of the flagellar segments, the wing pads, and other diagnostic features are similar to those of the Minnesota ♀.

Wasmaniella properly belongs to the tribe Lestremiini rather than to the tribe Micromyini, where it was referred by Kieffer and Felt. This is demonstrated by: the two ocelli; the short eye bridge, which is narrowed and devoid of facets medially; the tarsal vestiture, which is all of the same length; the short ovipositor; and the lack of sclerotized spermathecae.

Several alate ♂♂ from Minnesota agree with the apterous ♀ in having the eye bridge widely devoid of facets medially and in having the flagellum provided with bladelike sensorial processes. They are undoubtedly congeneric.

The wing venation of the ♂ is similar to that of *Anaretella* but differs from this and other genera in having R_1 very short and r-m forming a straight line with R_5 and having its proximal end well before the subobsolete R_s. The ♂ hypopygium is similar to that of *Anaretella* except that the tegmen is simple and the genital rod is weak. The flagellum differs from *Anaretella* in having but a single crenulate whorl and in having the sensorial processes very long and slender.

Ocelli two. Eye bridge strongly narrowed and with median portion devoid of facets. Mystax consisting of several bristles above facial protuberance. Antenna of ♂ with 2 + 14 segments, the flagellum (fig. C, 23) with long stems; enlargements each with a single crenulate whorl, distally set with long bristles and long, slender sensorial processes. Antenna of ♀ with 2 + 10 or 11 (possibly 13) segments, the flagellar segments obovate with distal stems; enlargements with bladelike sensorial processes distally. Palpi four-segmented, the first segment with sensory spines inside. ♂ alate; wings (fig. A, 4) moderately covered with macrotrichia; R_1 very short; R_s subobsolete; R_5 ending abruptly at level of tip of M_{3+4}; r-m long; medial fork about twice length of stem, with the upper branch infuscated, the stem arising well before R_s; M_{3+4} arising just beyond base of r-m. ♀ with short wing pads. Claws with a broadly angulate tooth near apex inside, without lateral teeth. Hypopygium with ninth tergite rather short; tenth tergite a pair of well-developed lobes; basiforceps united below for a moderate distance, the roots directed anteriorly; distiforceps tapering, with hyaline cusp at tip; tegmen broad; genital rod weak. Ovipositor (fig. C, 25) short, the lamellae with penultimate segment broad and short.

Wasmaniella aptera was reared from a larva found beneath a leaf sheath of *Scirpus sylvaticus* in Europe.

Wasmaniella clauda, n. sp.

W. clauda differs from *W. aptera* in that the ♀ of *clauda* possesses only ten flagellar segments, the last of which is very small, whereas the ♀ of *aptera* was described as having thirteen flagellar segments (eleven flagellar segments were

shown in the illustration). The stems of the flagellar segments are also shorter than that indicated for *aptera* in Kieffer's drawing.

Male.—Flagellum (fig. C, 23) with stems of middle segments slightly longer than enlargements, shorter on distal and proximal segments. Palpus with segments successively increasing in length. Hypopygium (fig. B, 10) with ninth tergite broadly angulate on caudal margin; tegmen broad near base, narrower on distal half and with obtuse median projection distally. Length of wing, 1.4 mm.

Female.—Flagellum (fig. C, 21) with ten segments, the terminal one being very small; stems of segments beyond the middle about ½ length of enlargements, somewhat shorter on proximal segments.

Holotype.—♂, John Latch State Park, Minnesota, May 29, 1941, A. E. Pritchard; in the writer's collection.

Allotype.—♀, Blackduck, Minnesota, Apr. 25, 1941, A. W. Buzicky.

Paratypes.—1 ♂, Afton, Minnesota, May 18, 1941, H. K. Knutson; 1 ♂, Vineland, Minnesota, May 24, 1941, A. E. Pritchard.

Conarete, n. gen.

Type of genus.—Conarete crebra, n. sp.

The genus *Conarete* is closely allied to *Anarete,* from which it differs in having the flagellar segments of the ♂ with distinct stems, at least on the more distal segments, and each with a crenulate whorl of long bristles; the roots of the basiforceps shorter and the proximolateral roots of the tegmen short and directed ventrolaterally; the anterior tarsus of the ♀ with a sole of short, dense, erect bristles on the proximal segments; and the wings generally more extensively covered with macrotrichiae. *Conarete* forms a connecting link between *Anarete* and genera more closely allied to *Lestremia.*

Ocelli two or none. Eyes contiguous, the bridge one to four facets wide medially. Antenna of ♂ with 2 + 7 to 9 segments; flagellar segments, at least the more distal ones, provided with distinct stems; the proximal enlargements each with a distinct but incomplete whorl of closely set, long bristles medially, and with short sensory spines distally. Antenna of ♀ with 2 + 9 segments, the flagellar segments obovate, the distal segments slenderer, and each with a very short distal neck, clothed with a proximal whorl of longer bristles set wide apart and distally with many short bristles; terminal segment compound, slightly constricted near end. Palpi four-segmented, long; the first with sensory bristles inside in both sexes. Wing membrane densely or moderately covered with macrotrichiae or with these more or less confined to distal third of wing and posterior margin; C extending ⅔ to ¾ of length of wing and ending just beyond union with end of R_5; R_1 rather long; R_s obliterated; r-m short but distinct; medial fork several times as long as stem, not divergent medially; Cu_1 arising before r-m; veins M except division proximal to r-m, Cu, and A each with a row of setae. Claws of ♂ strongly bent, with a somewhat enlarged angulation inside medially and with a series of variously developed external teeth; claws of ♀ with teeth small; empodium less than length of claws, with fine hairs below. Anterior tarsus of ♀ with proximal three segments provided with sole of several dense rows of short, erect bristles. Hypopygium with tenth tergite bilobed, separated from ninth tergite by long membranous area; basiforceps narrowly united below, with roots short, directed anteriorly, and connected by a bridge; distiforceps rather elongate; tegmen elongate, the proximoventral roots short; genital rod slender, the tip simple. Ovipositor rather short, the penultimate segment of the lamella short and broad.

Aside from the following North American species, the genus also contains [*Anarete indica* (Mani)] = *Conarete indica* (Mani), new combination, from India and [*Anarete calcuttaense* Nayar] = *Conarete calcuttaense* (Nyar), new combination, from India. These two species differ from the nearctic ones in having the claw of the ♂ provided with three very long teeth externally. *Calcuttaense* was

described as differing from *indica* in having seven rather than six flagellar segments in the ♂. The drawing presented by Mani (1934), however, indicates that the ♂ of *indica* has seven flagellar segments and that the scape was overlooked. *Calcuttaensis* is probably a synonym of *indica*. Dr. Mani informed the writer that the Indian species lack ocelli.

A series of ♀♀ are at hand from southeastern Minnesota that agree with *Conarete* in having a sole of short, dense bristles on the fore tarsus. They differ from the known ♀♀ of *Conarete*, however, in having only eight flagellar segments, as in *Anarete*, and in having the proximal segment of the ovipositor proportionally long, as in *Anarete*. The relationship of these ♀♀ can be ascertained when the ♂ is known.

KEY TO NORTH AMERICAN SPECIES

Males

1. Ocelli absent 2
   Ocelli present; claw with two long teeth medially 3
2. Claw widened and pectinate distally; distiforceps with an elongate mediolateral lobe and with a strong distal spine; eye bridge three facets wide medially .... *eschata*, n. sp.
   Claw acuminate distally, with a single long tooth medially; distiforceps without lobe and with small distal spine; eye bridge one facet wide medially .... *eluta*, n. sp.
3. Wings pale; eye bridge two to three facets wide medially .... *texana* (Felt)
   Wings brown; eye bridge four facets wide medially .... *crebra*, n. sp.

Conarete crebra, n. sp.

C. crebra may be recognized by having the ocelli present, the eye bridge four facets wide medially, and the wings distinctly brown and densely covered with macrotrichiae. The ♂ has two long teeth on the claw, and the basiforceps have a broad proximoventral lobe inside.

Ocelli two. Eyes with bridge four facets wide medially. Palpi long, four-segmented. Wings (fig. A, 6) brownish, densely covered with macrotrichiae; R_1 ending well before level of end of M_{3+4}.

Male.—Flagellum nine-segmented, the stems of segments five to eight about ½ as long as enlargements (the eighth segment with stem variable, sometimes absent and coalescing with segment nine). Claw (fig. C, 27) with two very long teeth externally, along with small, more proximal teeth; empodium ½ length of claw. Basiforceps (fig. B, 14) with broad proximoventral lobe inside and with a group of bristles near distal end inside on a narrow protuberance (the projection variable in size); distiforceps elongate-elliptical, cupped inside, with small terminal cusp (possibly two); tegmen very long and slender, slightly widened beyond the middle; genital rod very long, extending beyond tegmen. Length of wing, 2.2 mm.

Female.—Flagellum nine-segmented, the terminal segment with distal cone; segments subelliptical with small distal stems; third segment with enlargement 1½ times as broad as long. Claws without strong teeth; empodium very short. Ovipositor with penultimate segment about as broad as long. Length of wing, 2.9 mm.

Holotype.—♂, Brauerville, Minnesota, Aug. 6, 1941, A. E. Pritchard; in the writer's collection.

Allotype.—♀, Brauerville, Minnesota, Aug. 6, 1941, A. E. Pritchard.

Paratypes.—2 ♂♂, 1 ♀, Houston Co., Minnesota, May 30, 1941, A. E. Pritchard; 1 ♀, Park Rapids, Minnesota, July 4, 1941, A. E. Pritchard.

Conarete texana (Felt), new combination

Microcerata texana Felt, 1913, Bull. N.Y. State Mus., 165:147
Anarete texana (Felt): Nayar, 1949, Proc. Roy. Ent. Soc. Lond., 18 (ser. B): 80.

C. texana is very closely related to *crebra* and resembles that species in having the ocelli present and the ♂ with two long external teeth on the claw and the

basiforceps with a broad lobe inside proximoventrally (the ocelli were not noted in the type, and it lacks tarsi). It differs from *crebra*, however, in having the wings pale and the eye bridge narrower, only two to three facets wide medially. The wings are more sparsely covered with macrotrichiae than in *crebra*, and the size is larger.

Monotype.—♂, in the New York State Museum.

Specimens examined.—MINNESOTA: 1 ♂, 1 ♀, Houston Co., May 30, 1941, A. E. Pritchard. TEXAS: 1 ♂, Plano, July, 1907, E. S. Tucker (monotype of *texana*).

Conarete eschata, n. sp.

Eschata differs from all other species of *Conarete* in the ♂ sex by having a palmate expansion near the distal end of the claw. The hypopygium is distinctive in that the distiforceps bear a thin, narrow projection near the middle above. The ocelli are absent, and the eye bridge is three facets wide; the ♀ may be recognized by these characters.

Ocelli absent. Eye bridge three facets wide. Palpi four-segmented, long. Wings pale, with macrotrichiae rather sparse (more extensive in ♀); R_1 ending before level of end of M_{3+4}. Mesonotum with three wide, dark vittae.

Male.—Flagellum eight-segmented; segments two to six with short but distinct stems; terminal segment elongate. Claws (fig. C, 29) with the denticles on a spatulate protuberance extending beyond the tiny tip of the claw; empodium somewhat over ½ length of claw. Hypopygium (fig. B, 15) with basiforceps strongly narrowed just beyond broad approximate portion below, with a small cluster of setae at inner, distal end; distiforceps elongate-elliptical, with a projecting lamella near middle above and with a strong spine terminally; tegmen about twice as long as wide at base, slightly narrowing caudally; genital rod strong, widened before tip, extending to end of tegmen. Length of wing, 1.5 mm.

Female.—Flagellum nine-segmented, but the eighth and ninth segments coalesced; segments about 1½ times as long, with short but distinct terminal stems. Claw acuminate, with a tiny but stout mediolateral tooth; empodium very short. Ovipositor with proximal segment of lamella as broad distally as long. Length of wing, 2.0 mm.

Holotype.—♂, Houston Co., Minnesota, May 30, 1941, A. E. Pritchard; in the writer's collection.

Allotype.—♀, Frontenac, Minnesota, May 29, 1941, A. E. Pritchard.

Conarete eluta, n. sp.

Eluta differs from other North American species of *Conarete* in having the eye bridge narrow, about one facet wide medially. Ocelli are absent. The ♂ is distinctive in having the claws each with a single very long tooth externally.

Ocelli absent. Eye bridge about one facet wide medially. Palpus four-segmented, long. Wings pale, with macrotrichiae sparse, largely confined to distal end and posterior margin; R_5 ending at level of end of M_{3+4}.

Male.—Flagellum seven-segmented, terminal segment with constriction just beyond crenulate whorl (or elongate with decided constriction, or eight-segmented); middle segments slender, with stems about ½ length of enlargements. Claw (fig. C, 28) with the distal tooth outside strongly lengthened, reaching nearly to end of claw; empodium somewhat over ½ length of claws. Basiforceps (fig. B, 16) gradually narrowed distally, with a small patch of setae near distal end inside; distiforceps elongate-elliptical, cupped inside, with a small terminal cusp; tegmen slender, tapering; genital rod slender, much longer than tegmen. Length of wing, 2.0 mm.

Female.—Flagellum (fig. C, 20) nine-segmented, the terminal segment elongate; other segments subelliptical, distinctly longer than broad and with short terminal stems. Claws acute, without

strong teeth; empodium very small. Ovipositor (fig. C, 26) with proximal segment of lamella as broad as long. Length of wing, 1.7 mm.

Holotype.—♂, Houston Co., Minnesota, May 30, 1941, A. E. Pritchard; in the writer's collection.

Allotype.—♀, Houston Co., Minnesota, May 29, 1941, A. E. Pritchard.

Paratypes.—3 ♂♂, Appleton, Minnesota, June 18 and Aug. 10, 1941, A. E. Pritchard; 1 ♂, 1 ♀, Frontenac, Minnesota, May 29, 1941, A. E. Pritchard; 2 ♀♀, Houston Co., Minnesota, May 30, 1941, A. E. Pritchard; 1 ♀, St. Paul, May 17, 1941, A. E. Pritchard.

Anarete Haliday

Anarete Haliday, 1833, Ent. Mag., 1:156; Macquart, 1835, Hist. Nat. Insect., Dipt., 2 (suppl.): 653; Westwood, 1840, Introd. Classif. Insect., Gen. Syn., p. 127; Loew, 1845, Ent. Ztschr. ent. Ver. Stettin, 6:396; Walker, 1856, Ins. Brit., Dipt., 3:60; Schiner, 1864, Faun. Austr., Flieg., 2:xvii, 353; Osten Sacken, 1893, Berl. ent. Ztschr., 37 (1892):451; Kieffer, 1900, Ann. Soc. Ent. France, 69:434; Kieffer, 1906, Ann. Soc. Sci. Bruxelles, 30:338; Enderlein, 1911, Stettiner ent. Zeitung, 72:130; Enderlein, 1911, Arch. Naturg., 77 (Bd. 1, Suppl. 3):194; Edwards, 1928, Insect. Samoa, 6:29; Edwards, 1929, Ent. Mo. Mag., 65:13; Edwards, 1938, Proc. Roy. Ent. Soc. Lond., 7 (ser. B):28.

Molobraea (*Anarete*) Loew, 1850, Dipt. Beitrag., 4:32.

Anarete (*Pseudanarete*) Kieffer, 1906, Ann. Soc. Sci. Bruxelles, 30:342.

Microcerata Felt, 1908, Bull. N.Y. State Mus., 124:308; Felt, 1911, Jour. N.Y. Ent. Soc., 19:32; Felt, 1913; Bull. N.Y. State Mus., 165:142; Kieffer, 1913, Gen. Insect., 152:309; Edwards, 1928, Insect. Samoa, 6:39; Mani, 1934, Rec. Ind. Mus., 36:381.

Limnopneumella Enderlein, 1911, Arch. Naturg., 77 (Bd. 1, Suppl. 3):195.

Limnopneuma Enderlein, 1911, Arch. Naturg., 77 (Bd. 1, Suppl. 3):196.

Type of genus.—Monobasic (second species questionably included), *Anarete candidata* Haliday.

Types of generic synonyms.—*Pseudanarete:* monobasic [*Anarete* (*Pseudanarete*) *crassipalpus* Kieffer] = *Anarete lacteipennis* Kieffer; *Microcerata:* by original designation, *Micromyia corni* Felt; *Limnopneumella:* monobasic, and by original designation, *Anarete stettinensis* Enderlein; *Limnopneuma:* monobasic, and by original designation, *Anarete coracina* (Zetterstedt).

The generic synonymy made by Edwards (1929) is accepted without reservation. *Microcerata* was described without reference to *Anarete,* a genus that Schiner and Kieffer had considered as being related to the scatopsids and bibionids. *Pseudanarete, Limnopneuma,* and *Limnopneumella* were all erected on a basis of sexually dimorphic characters.

Many of the species belonging to the genus *Anarete* are difficult to determine. The ♂ genitalia are all very similar. Variations in the number and form of the antennal segments, the distribution of macrotrichiae on the wings and the setation of the veins, and the width of the eye bridge, all appear to be characters subject to some variation. The size of the empodium appears to be of specific value, but it is difficult to refer precisely to its length in comparison with the strongly bent claws. Pinned material may be of considerable aid in differentiating the species.

Members of the genus *Anarete* are found commonly in shaded woods, in cultivated fields, on windows, or at lights. Several species have been found in sand-dune areas, an unusual habitat for midges whose larvae are scavengers. The ♂♂ of several species are known to form large swarms, a habit that is known elsewhere only in the genus *Campylomyza* among gall midges.

Microcerata ocoteae Köhler (1932) was described from Argentina as the maker of a polythalmous stem gall on *Ocotea.* The drawing of the holotype ♂ shows that this species belongs to the family Lycoriidae (Sciaridae), and its role as a gall maker is extremely doubtful.

KEY TO NORTH AMERICAN SPECIES

MALES

1. Wings whitish or milky 2
   Wings pale brownish or grayish 5
2. Claw with a denticulate expansion distally .... *buscki* (Felt)
   Claw acuminate distally 3
3. Palpus with proximal segment noticeably enlarged .... *lacteipennis* (Kieffer)
   Palpus with proximal segment unenlarged 4
4. Basiforceps with setose swelling on inner side distally; hind leg with basitarsus ⅔ length of tibia .... *edwardsi*, n. sp.
   Basiforceps without setose enlargement; hind leg with basitarsus ½ length of tibia *johnsoni* (Felt)
5. Palpus three-segmented .... *diervillae* (Felt)
   Palpus four-segmented 6
6. Empodium not over ½ length of claws; claw with a single, small lateral tooth by tip *anepsia*, n. sp.
   Empodium about as long as claws or longer 7
7. Flagellum with distal segments slender and bearing some setae much longer than on proximal segments; empodium much longer than claws .... *felti*, n. sp.
   Flagellum with distal segments subglobular and with longer setae of same length as on proximal segments 8
8. Empodium much longer than claws .... *rubra* Kieffer
   Empodium approximately as long as claws .... *corni* Felt

Anarete edwardsi, n. sp.

A. edwardsi is closely related to the genotype *A. candidata* Haliday and resembles that species in having the wings milky white, the hind basitarsus of the ♂ proportionally long, and in being large in size. The body is even larger than in *candidata*, however; the ♂ flagellum is slenderer; and the basiforceps are swollen on the inside distally. The antennae of both sexes lack the deep sensory pockets on the proximal flagellar segments, a characteristic of specimens of *candidata*, determined by Edwards and studied by the writer. Edwards (1938) did not mention the presence of these pockets in his redescription of *candidata*, but they are indicated in the proximal flagellar segment of his drawing of the ♂ antenna.

This species is named in honor of the late Dr. F. W. Edwards, who made such significant contributions to the classification of the lestremiine gall midges.

Ocelli two. Eye bridge two facets wide medially. Palpus four-segmented, the first segment slender, the fourth segment nearly twice length of third. Wings white; setae present on median fork except base and on end of M_{3+4} but not on A; macrochaetae present at end of wing beyond R_5 and above M_{3+4}; M_{3+4} arising proximally before r-m.

Male.—Antenna with 2 + 7 segments; pedicel strongly enlarged; flagellum with first three segments broader than long, the more distal segments slender, longer than wide, and with some of the setae very long; sensory spines not in pockets. Hind leg with basitarsus ⅔ length of tibia; claw strongly curved, acuminate distally and with small proximolateral teeth; empodium about as long as claws. Hypopygium with basiforceps having a strong, setose swelling on inside distally; distiforceps swollen near base, narrowed and cupped distally; tegmen long and slender. Length of wing, 2.0 mm.

Female.—Antenna 2 + 8 segments; pedicel smaller than in ♂; flagellum with first six segments subelliptical and wider than long, the seventh segment considerably wider than long, and the terminal segment very slender, narrowed before end; sensory bristles not in pockets. Hind leg with basitarsus about ½ length of tibia; claw with proximolateral denticles very fine; empodium

about ½ length of claws. Ovipositor with penultimate segment of lamella slender, twice as long as wide. Length of wing, 2.8 mm.

Holotype.—♂, Anoka, Minnesota, June 15, 1941, A. E. Pritchard, sand dunes; in the writer's collection.

Allotype.—♀, Anoka, Minnesota, June 15, 1941, A. E. Pritchard, sand dunes.

Paratypes.—7 ♂♂, 6 ♀♀, Anoka, Minnesota, June 15, 1941, A. E. Pritchard, sand dunes.

Anarete johnsoni (Felt)

Microcerata johnsoni Felt, 1908, Bull. N.Y. State Mus., 124:310; Felt, 1913, Bull. N.Y. State Mus., 165:143 (fig. ♂ antenna).

Anarete johnsoni (Felt): Edwards, 1929, Ent. Mo. Mag., 65:14.

Microcerata cockerelli Felt, 1908, Bull. N.Y. State Mus., 124:310; Felt, 1913, Bull. N.Y. State Mus., 165:144. New synonymy.

Microcerata spinosa Felt, 1913, Bull. N.Y. State Mus., 165:145 (fig. ♂ antenna, palp). New synonymy.

Microcerata iridis Cockerell, 1914, Jour. Econ. Ent., 7:460 (fig. portion of wing). New synonymy.

Microcerata aldrichii Felt, 1915, Canad. Ent., 47:226. New synonymy.

Anarete heracleana Edwards, 1938, Proc. Roy. Ent. Soc. Lond., 7 (ser. B):29 (fig. wing, ♂ antenna, palp, genitalia). New synonymy.

Johnsoni may be recognized by the pale-white wings together with the acuminate claws of the ♂, the comparatively short basitarsus of the ♂, and the unexpanded basipalps of both sexes. The body and wings are considerably smaller than in *candidata* or *edwardsi.*

The empodium of the ♂ is considerably longer than the claws, and the claw bears, in addition to the small lateral teeth, a small, slender, proximodorsal tooth, which is evident in most of the mounted specimens.

The flagellum of the ♂ may be six-segmented, with the terminal segment simple or compound; or seven-segmented, with the terminal segment simple or with a terminal nipple. The proximal two segments of the ♂ flagellum are rather broad, with the sensory spines set in very shallow pockets; the distal segments are slender and bear some bristles which are very long. Proximal segments of the ♀ flagellum also have the sensory spines set in shallow pockets.

The eye bridge is very narrow, not over one facet wide except in 3 ♂♂ from Detroit Lakes, Minnesota. These ♂♂ show no other apparent differences from typical *johnsoni.*

Microcerata cockerelli, M. spinosa, M. iridis, and *M. aldrichii* are all considered synonyms of *johnsoni.* The types of these species show no significant differences except in the number of antennal segments or the form of the distal flagellar segments, and these characters are shown to be variable in the large series studied.

The description of *Anarete heracleana* agrees well with North American material and shows that *johnsoni* also occurs in Europe. If this species is as common in Europe as in North America, the names *Anarete albipennis* (Meigen) and *Anarete stettinensis* Enderlein might apply here.

Monotype.—♂, in the New York State Museum.

Types of synonyms.—*Cockerelli:* cotypes, 2 ♂♂ (on one slide), in the New York State Museum; *spinosa:* lectotype ♂ (the only slide preparation), by present designation, in the New York State Museum; *iridis:* cotypes 2 ♂♂ (on one slide), in the U.S. National Museum, and 3 ♂♂ (on two slides), in the New York State Museum; *aldrichii:* lectotype ♂ (the only slide preparation of this sex), by present designation, in the New York State Museum; *heracleana:* 15 ♂♂ and 1 ♀ (no

specific type mentioned, although Edwards usually designated a type), in the British Museum (Natural History).

Specimens examined.—CALIFORNIA: 1 ♂, Orinda, Mar. 12, 1947, A. E. Pritchard; 2 ♂♂, Walnut Creek, Apr. 16, 1947, A. E. Pritchard. COLORADO: 5 ♂♂, Boulder [July 13, 1915, T.D.A.] Cockerell (cotypes of *iridis*). FLORIDA: 3 ♂♂, 40 ♀♀, Jacksonville, July 27, 1945, A. E. Pritchard; 1 ♂, 13 ♀♀, West Palm Beach, July 21, 1945, A. E. Pritchard. IDAHO: 1 ♂, Moscow, June 24, 1912, J. M. Aldrich; 2 ♂♂, Moscow, J. M. Aldrich; 1 ♀, Viola, June 29, 1912, J. M. Aldrich. INDIANA: 54 ♂♂, 1 ♀, Lafayette, Apr. 30 to May 13, 1915, J. M. Aldrich; 9 ♂♂, 6 ♀♀, Lafayette, May 3, 1915, J. M. Aldrich (determined by Felt as *aldrichii*); several hundred adults (in alcohol), May 13, 1915, J. M. Aldrich (determined by Felt as *aldrichii*); 6 ♂♂ (on cardpoint), Lafayette, J. M. Aldrich (determined by Felt as *aldrichii*); 1 ♀, Vincennes, May 1, J. M. Aldrich, swept from winter wheat (determined by Felt as *aldrichii*); 4 ♂♂ (3 of the ♂♂ on cardpoint), 1 ♀, Vincennes, May 6, 1914 [J. M. Aldrich] swept from winter wheat (lectotype and paralectotypes of *aldrichii*); 25 ♂♂, Vincennes, May 6 and May 9, 1915, J. M. Aldrich. KANSAS: 41 ♂♂, Cedar Vale, Aug. 27, 1938, C. E. Burt. MARYLAND: 1 ♂, Chesapeake Beach, Sept. 6, J. M. Aldrich. MICHIGAN: 1 ♂, Detroit, July 10, 1935, G. Steyskal. MINNESOTA: 1 ♂, Afton, May 18, 1941, A. E. Pritchard; 8 ♂♂, 2 ♀♀, Appleton, June 18 and Aug. 10, 1941, A. E. Pritchard; 4 ♂♂, Bemidji, July 30, 1941, A. E. Pritchard, at light; 1 ♂, Campbell, Oct. 15, 1941, D. G. Denning; several thousand ♂♂, Felton, June 1, 1938, A. E. Pritchard; several hundred ♂♂, Hallock, June 23, 1938, H. P. Nicholson; 1 ♂, Hawley, July 28, 1941, A. E. Pritchard; 2 ♂♂, Houston Co., May 31, 1941, A. E. Pritchard; 2 ♂♂, St. Paul, May 12, 1941, A. E. Pritchard; 1 ♂, Vineland, May 24, 1941, A. E. Pritchard; 7 ♂♂, 1 ♀, Wolverton, Aug. 9, 1939, A. E. Pritchard. NEW MEXICO: 1 ♂, Las Cruces, June 14, 1917, J. M. Aldrich; 2 ♂♂, Mesilla [Aug., T.D.A. Cockerell] (cotypes of *cockerelli*). NORTH DAKOTA: 34 ♂♂, Merricourt, July 13, 1913, C. N. Ainslie, from swarms in lee of buildings. PENNSYLVANIA: 1 ♂, Philadelphia, Aug. 2, 1891, C. W. Johnson (monotype of *johnsoni*). TEXAS: 2 ♂♂ (1 on cardpoint), 1 ♀ (on cardpoint), Plano, May, 1907, E. S. Tucker, at dusk in oat field (lectotype and paralectotypes of *spinosa*); 1 ♂ (on cardpoint), Plano, Oct., E. S. Tucker, in oat field (determined by Felt as *spinosa*). WASHINGTON: 1 ♀, American River, June 10, 1948, A. E. Pritchard; 2 ♂♂, Parkway, June 19, 1948, A. E. Pritchard; 3 ♂♂, Union Flat, June 16, 1916, J. M. Aldrich. WISCONSIN: 22 ♂♂, 1 ♀, Elmwood, May 17, 1942, D. G. Denning.

Anarete buscki (Felt), new combination

Microcerata buscki Felt, 1915, Proc. U.S. Natl. Mus., 48:198.

Buscki is very similar to *johnsoni*, but differs mainly in having the claw of the ♂ distally expanded and bearing five small teeth. The wings are similarly whitish, with M_{3+4} arising proximal to r-m, and with the macrotrichiae of the ♂ confined to the end of the wing. Ocelli are present, and the eye bridge is narrow. The basipalps are unenlarged. The basitarsus of the ♂ hind leg is ½ the length of the tibia. The ♂ flagellum is seven-segmented, with the distal segments slender and bearing some longer bristles. The ♂ genitalia are similar to *johnsoni* except that the tegmen is caudally sclerotized, abruptly narrowed pedistally, and with the end acuminate.

The ♀ is very similar to that of *johnsoni*.

Monotype.—♂, in the U.S. National Museum.

Specimens examined.—MINNESOTA: 28 ♂♂, Appleton, Aug. 10, 1941, A. E. Pritchard; 1 ♂, Bemidji, July 30, 1941, A. E. Pritchard, at light. CUBA: 1 ♂, Baracoa, September, 1901, August Busck (monotype of *buscki*). PUERTO RICO: 2 ♂♂, 1 ♀, Juana Díaz, Sept. 11, 1942, A. E. Pritchard.

Anarete lacteipennis Kieffer

Anarete lacteipennis Kieffer, 1906, Ann. Soc. Sci. Bruxelles, 30:345 (fig. ♂ palp and wing); Edwards, 1929, Ent. Mo. Mag., 65:15; Edwards, 1938, Proc. Roy. Ent. Soc. Lond., 7 (ser. B):29 (fig. wing, ♂ antenna, palp, and genitalia).

Anarete (Pseudanarete) crassipalpus Kieffer, 1906, Ann. Soc. Sci. Bruxelles, 30:346 (fig. ♀ palp).

Lacteipennis is very similar to *johnsoni* except that the proximal segment of the palpus is somewhat enlarged in the ♂ and very strongly enlarged in the ♀, and its inner surface is densely covered with sensory bristles. The wings are white; vein M_{3+4} arises distal to r-m.

This species was originally described from Styria, and it was redescribed by Edwards from material collected in England. This is the first record of its occurrence in North America. Edwards has indicated that the name *Anarete albipennis* Loew (not Meigen) could apply here.

Type.—♂(s), probably lost.

Type of synonym.—*Crassipalpus:* ♀(s), probably lost.

Specimens examined.—MINNESOTA: 3 ♀♀, Afton, May 10, 1941, A. E. Pritchard.

Anarete diervillae (Felt), new combination

Micromyia diervillae Felt, 1907, Bull. N.Y. State Mus., 110:103.

Microcerata diervillae (Felt): Felt, 1908, Bull. N.Y. State Mus., 124:310; Felt, 1913, Bull. N.Y. State Mus., 165:145.

A. diervillae may be recognized by having the palpus three-segmented, with the first segment unenlarged. The wings are brownish, with the anal angle squarely rounded. The ♂ flagellum is seven-segmented, with the segments pyriform except the terminal segment, which is elongate.

The monotype ♂ of *diervillae* corresponds to the description given by Edwards (1938) of *A. coracina* Zetterstedt, but Edwards' identification cannot be accepted until Zetterstedt's type is examined.

Monotype.—♂, at the New York State Museum.

Specimens examined.—NEW YORK: 1 ♂, Karner, June 5, 1906 (not 1907) (monotype of *diervillae*).

Anarete felti, n. sp.

Felti may be recognized by having the wings pale brownish and the ♂ with the empodium much longer than the claws and the distal flagellar segments slender and bearing long bristles. It is very similar to *johnsoni,* but the wings are not white, as in that species.

This species is named in honor of Dr. E. P. Felt, who pioneered the taxonomy of the lestremiine gall midges in North America.

Ocelli two. Eye bridge one facet wide medially. Wings light brownish, the anal angle bluntly right-angled; macrotrichiae scattered around end of wing beyond R_1.

Male.—Flagellum six-segmented, the sixth segment compound (or with the sixth segment subdivided to form seven segments); second flagellar segment slightly broader than long and with short whorl bristles; third segment slightly longer than broad; fourth, fifth, and sixth segments narrower and slenderer and with some of the whorl and terminal bristles very long. Palpus four-segmented, the first and second about equal in size, the third slightly longer, and the fourth slightly longer than first two combined. Claws acuminate with slender mediolateral teeth; empodium considerably longer than claws. Hypopygium with basiforceps slender; tegmen moderately slender. Length of wing, 1.2 mm.

Female.—Flagellum eight-segmented, the eighth segment with terminal cone, segments two through six slightly longer than broad, the sensory bristles set in very shallow pockets on either side. Empodium about ½ length of claws. Length of wing, 1.4 mm.

Holotype.—♂, Wayzata, Minnesota, May 16, 1942, A. E. Pritchard; in the writer's collection.

Allotype.—♀, Appleton, Minnesota, Aug. 10, 1941, A. E. Pritchard.

Paratypes.—MINNESOTA: 2 ♂♂, Afton, May 10 and 18, 1941, A. E. Pritchard; 1 ♂, Alexandria, June 23, 1941, A. E. Pritchard; 4 ♂♂, Anoka, June 15, 1941, A. E. Pritchard; 46 ♂♂, 2 ♀♀, Appleton, June 17 and Aug. 10, 1941, A. E. Pritchard; 1 ♂, Crookston, July 29, 1941, A. E. Pritchard; 2 ♂♂, Detroit Lakes, June 30, 1941, A. E. Pritchard; 16 ♂♂, 8 ♀♀, Frontenac, May 29, 1941, A. E. Pritchard; 60 ♂♂, Houston Co., May 29 and 30, 1941, A. E. Pritchard; 18 ♂♂, 7 ♀♀, Mentor, July 30, 1941, A. E. Pritchard; 1 ♂, Preston, June 1, 1941, A. E. Pritchard; 2 ♂♂, 2 ♀♀, St. Paul, May 17 and July 19, 1941, A. E. Pritchard; 1 ♂, Wadena, July 3, 1941, A. E. Pritchard.

Anarete rubra Kieffer

Anarete rubra Kieffer, 1906, Ann. Soc. Sci. Bruxelles, 30:33 (fig. ♂ antenna, wing, genitalia, and ovipositor).

Anarete rubra has been known from a single collection from Bitche, Kieffer's home town, then in Germany. The name is here applied to a species that conforms with Kieffer's description and drawing in having the wings pale brownish (as opposed to whitish), the empodium of the ♂ longer than the claws, and the flagellum of the ♂ with the longer bristles of the flagellum of the same length on all the segments. The character of the flagellum will separate *rubra* from *felti*, to which it is very closely related, and the longer empodium separates *rubra* from *corni*.

The flagella of the ♂♂ studied are seven-segmented, with the seventh segment usually simple but sometimes more or less compound. The more distal segments may be only slightly reduced in size or distinctly so as in Kieffer's figure.

The ♀ is very similar to that of *felti*, and characters have not been found for separating this sex of the two species.

Types.—♂(s) and ♀(s), probably lost.

Specimens examined.—CALIFORNIA: 3 ♂♂, Crescent City, June 6, 1948, A. E. Pritchard. MINNESOTA: 1 ♂, Anoka, June 15, 1948, A. E. Pritchard; 8 ♂♂, Bemidji, July 8, 1941, A. E. Pritchard; 1 ♂, Duluth, Aug. 2, 1941, A. E. Pritchard; 22 ♂♂, Houston Co., May 30, 1941, A. E. Pritchard; 23 ♂♂, 18 ♀♀, Itasca Park, July 7, 1941, A. E. Pritchard; 1 ♂, Wadena, July 3, 1941, A. E. Pritchard. OREGON: 1 ♂, Oregon Caves, June 7, 1948, A. E. Pritchard.

Anarete corni (Felt), new combination

Micromyia corni Felt, 1907, Bull. N.Y. State Mus., 110:102.

Microcerata corni (Felt): Felt, 1908, Bull. N.Y. State Mus., 124:310; Felt, 1913, Bull. N.Y. State Mus., 165:145.

Microcerata perplexa Felt, 1908, Bull. N.Y. State Mus., 124:310 (photog. wing); Felt, 1913, Bull. N.Y. State Mus., 165:146 (fig. antennal segments). New synonymy.

Microcerata borealis Felt, 1913. Bull. N.Y. State Mus., 165:147. New synonymy.

Anarete angustata Edwards, 1929, Ent. Mo. Mag., 65:16; Edwards, 1938, Proc. Roy. Ent. Soc. Lond., 7 (ser. B):30 (fig. wing, ♂ palpus, antenna, and genitalia). New synonymy.

Corni may be differentiated from other species of *Anarete* that have brownish wings by having the ♂ empodium nearly the length of the claws. The flagellar segments are subglobular, with the longer bristles of the same length throughout. *Corni* is very closely related to *rubra*, differing mainly in the shorter empodium of the ♂.

The flagellum of the ♂ is usually seven-segmented, with the seventh segment strongly compound. This is true of the types of *corni* and *angustata*. Variations occur, however, between having six flagellar segments, with the sixth segment compound, and having eight flagellar segments, with the eighth segment compound.

The latter condition is found in the type of *borealis*. The flagellar segments, except the terminal one, are approximately of the same size or somewhat decreasing in size distally.

The ♀ may be differentiated from the other species with lightly tanned wings by having flagellar segments two through six, each distinctly broader than long.

Monotype.—♂, at the New York State Museum.

Types of synonyms.—*Perplexa:* monotype ♀, at the New York State Museum; *borealis:* monotype ♂, at the New York State Museum; *angustata:* type ♂, at the British Museum (Natural History).

Specimens examined.—MINNESOTA: 3 ♂♂, Anoka, June 15, 1941, A. E. Pritchard; 3 ♂♂, 3 ♀♀, Anoka, June 16, 1942, D. G. Denning; 14 ♂♂, Appleton, June 18, 1941, A. E. Pritchard; 1 ♂, Bacchus, July 8, 1941, A. E. Pritchard; 1 ♂, Brauerville, Aug. 6, 1941, A. E. Pritchard; 1 ♂, Detroit Lakes, June 20, 1941, A. E. Pritchard; 1 ♂, St. Paul, July 19, 1941, A. E. Pritchard; 1 ♂, Two Harbors, June 23, 1941, A. E. Pritchard; 1 ♂, Zumbro Falls, Aug. 8, 1941, A. E. Pritchard. NEW YORK: 1 ♂, Albany, July 3, 1906 (not July 6, 1907) (monotype of *corni*); 1 ♀, July 13 (not 19), 1907, Albany, on office window (monotype of *perplexa*); 1 ♂, Speculator, July 27, 1907, D. B. Young (monotype of *borealis*). NORTH DAKOTA: 1 ♂, 1 ♀, Fargo, June 21, 1941, A. E. Pritchard. OREGON: 12 ♂♂, 2 ♀♀, Gold Hill, June 7, 1948, A. E. Pritchard. WASHINGTON: 4 ♂♂, 2 ♀♀, American River, June 10, 1948, A. E. Pritchard; 1 ♂ 5 ♀♀, Parkway, June 18, 1948, A. E. Pritchard.

Anarete anepsia n. sp.

Anepsia may be differentiated from all other known species of *Anarete* by having the empodium in the ♂ very short, not over ½ the length of the claws, and the claw of the ♂ without lateral denticles except for a small tooth by the tip. The wings are light brownish, and the antenna of the ♂ is very similar to that of *rubra* and *corni*.

The ♀ is very similar to that of *rubra* and *felti*, but the wings are extensively covered with macrotrichiae.

Ocelli two. Eye bridge one facet wide medially. Palpus four-segmented, the fourth segment about as long as first two combined. Wings (fig. A, 8) pale brownish; macrotrichiae sparsely covering most of wing, denser at end; medial fork with setae along tines and stem and M with setae beyond level of base of fork.

Male.—Flagellum seven-segmented, the seventh segment with a distal cone (or eight-segmented, the eighth segment with a small terminal cone in larger specimens); segments two through six pear-shaped, slightly longer than broad or about as long as broad; longer bristles of same length on all flagellar segments. Claw (fig. C, 30) acuminate, with a small lateral tooth near tip; empodium slightly less than ½ length of claws. Hypopygium with basiforceps slender; tegmen long and fairly broad. Length of wing, 1.5 mm.

Female.—Flagellum eight-segmented, the eighth segment with terminal cone (which is sometimes articulated to form a ninth segment); segments two through six pear-shaped, the third, fourth, fifth, and sixth slightly longer than broad. Claw with small mediolateral tooth, empodium slightly less than ½ length of claws. Length of wing, 2.2 mm.

Holotype.—♂, Orinda, California, Mar. 12, 1947, A. E. Pritchard; in the writer's collection.

Allotype.—♀, Orinda, California, Mar. 12, 1947, A. E. Pritchard.

Paratypes.—8 ♂♂, 8 ♀♀, Orinda, California, Mar. 12, 1947, A. E. Pritchard; 21 ♂♂, San Antonio Valley, California, Nov. 3, 1947, A. E. Pritchard; 1 ♂, Trail, Oregon, June 7, 1948, A. E. Pritchard.

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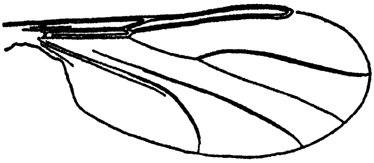
FIGURES

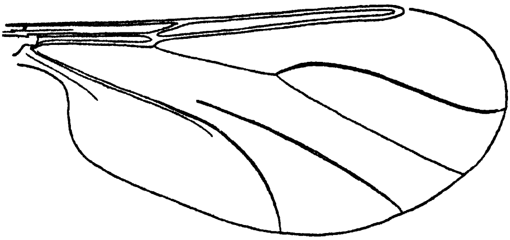
FIGURE A

1. Wing of *Lestremia solidaginis*, male, Detroit Lakes, Minnesota.
2. Wing of *Gongromastix schalis*, holotype.
3. Wing of *Anaretella iola*, paratype.
4. Wing of *Wasmaniella clauda*, holotype.
5. Wing of *Allarete vernalis*, male, Appleton, Minnesota.
6. Wing of *Conarete crebra*, holotype.
7. Wing of *Allarete barberi*, female, Wabasha, Minnesota.
8. Wing of *Anarete anepsia*, allotype.

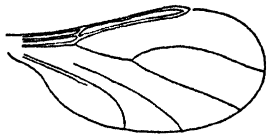


1. L. SOLIDAGINIS

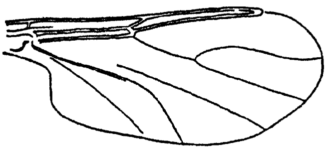
2. G. SCALIS



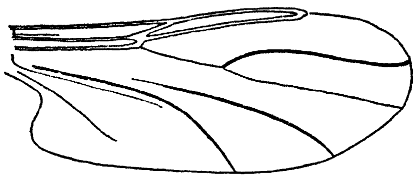
3. A. IOLA



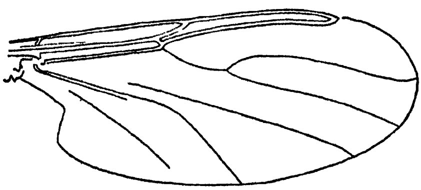
4. W. CLAUDA



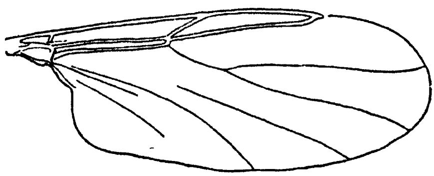
5. A. VERNALIS



6. C. CREBRA



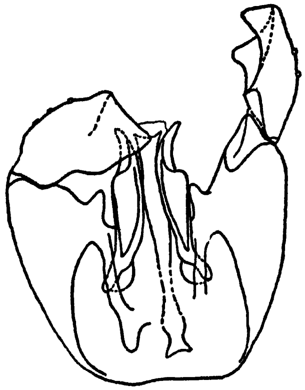
7. A. BARBERI



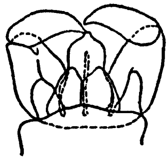
8. A. ANEPSIA

FIGURE B

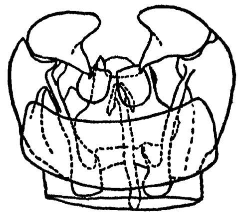
9. Dorsal aspect of hypopygium (ninth and tenth segments removed) of *Anaretella iola,* holotype.
10. Dorsal aspect of hypopygium of *Wasmaniella clauda,* holotype.
11. Dorsal aspect of hypopygium of *Gongromastix schalis,* holotype.
12. A. Dorsal aspect of hypopygium (ninth tergite removed) of *Lestremia solidaginis,* Afton, Minnesota.
    B. Ventral aspect of basiforceps of same specimen.
13. A. Dorsal aspect of hypopygium (ninth and tenth segments removed) of *Allarete vernalis,* Appleton, Minnesota.
    B. Sketch of tegmen of holotype of same species.
14. Dorsal aspect of hypopygium (ninth and tenth segments removed) of *Conarete crebra,* holotype.
15. Dorsal aspect of hypopygium (ninth and tenth segments removed) of *Conarete eschata,* holotype.
16. Dorsal aspect of hypopygium (ninth and tenth segments removed) of *Conarete eluta,* holotype.



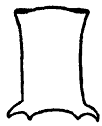
9. A. IOLA



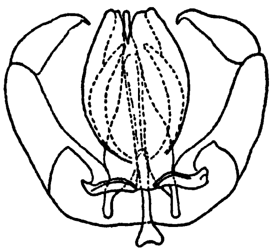
10. W. CLAUDA



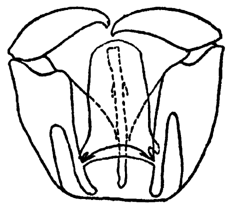
11. G. SCHALIS



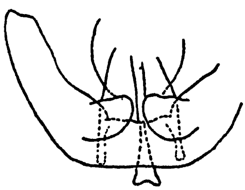
13B.



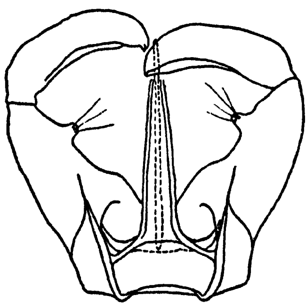
12A. L. SOLIDAGINIS



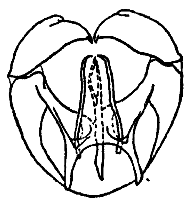
13A. A. VERNALIS



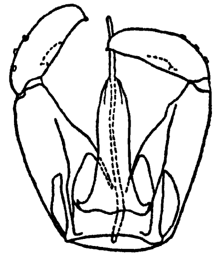
12B.



14. C. CREBRA



15. C. ESCHATA



16. C. ELUTA

FIGURE C

17. Third and fourth flagellar segments of female of *Lestremia leucophaea*, Wayzata, Minnesota.
18. Third and fourth flagellar segments of female of *Lestremia cinerea*, Berkeley, California.
19. Third, fourth, and fifth flagellar segments of female of *Allarete barberi*, Wabasha, Minnesota.
20. Proximal flagellar segments of female of *Conarete eluta*, paratype.
21. Portion of antenna of female of *Wasmaniella clauda*, allotype.
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23. Third and fourth flagellar segments of male of *Wasmaniella clauda*, holotype.
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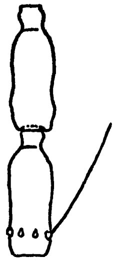
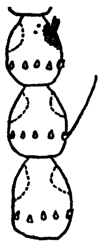
26. Lateral aspect of ovipositor of *Conarete eluta*, paratype.
27. Claw of male of *Conarete crebra*, holotype.
28. Claw of male of *Conarete eluta*, holotype.
29. Claw of male of *Conarete eschata*, holotype.
30. Claw of male of *Anarete anepsia*, holotype.

17. L. LEUCOPHAEA



18. L. CINEREA

22. A. IOLA

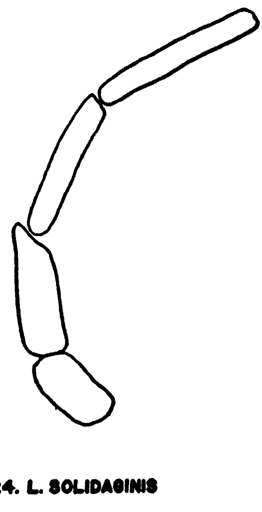


19. A. BARBERI

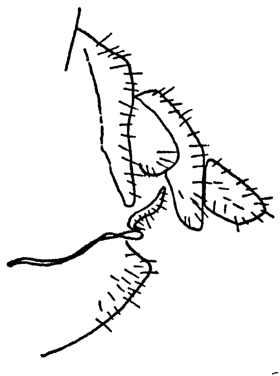
20. C. ELUTA

21. W. CLAUDA

23. W. CLAUDA



24. L. SOLIDAGINIS

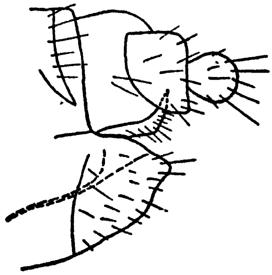


25. W. CLAUDA

27. C. CREBRA

28. C. ELUTA

30. A. ANEPSIA



26. C. ELUTA

29. C. ESCHATA

A REVISION OF THE GENUS AMBRYSUS IN THE UNITED STATES

(*Hemiptera: Naucoridae*)

BY

IRA LA RIVERS

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CONTENTS

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BY

IRA LA RIVERS

INTRODUCTION

THE PRESENT essay is the outgrowth of an attempt to monograph the entire genus *Ambrysus*, submitted as a thesis in partial fulfillment of the requirements for the degree of Doctor of Philosophy at the University of California at Berkeley. However, certain circumstances, predominant among which is the present inaccessibility of a few key European type specimens, prevent the realization of the original objectives so far as a complete coverage of the genus is concerned. In addition, much more collecting in the tropical Americas is necessary before a decisive picture of the phylogeny of the genus will emerge.

ACKNOWLEDGMENTS

I wish first to express my appreciation for the unstinting aid given to this project by Dr. Robert L. Usinger. In addition to first suggesting the problem for study, he generously placed his large and comprehensive collection at my disposal and was chiefly instrumental in obtaining the loan of the University of Kansas *Ambrysus* collection, without which little of a coherent nature could have been accomplished. The Usinger collection, accumulated over a period of more than twenty years, is a composite representation of the labors and energies of many collectors in various parts of the country. For example, it contains Utah material collected by A. M. Woodbury, Nevada material collected by E. R. Hall, Van Duzee specimens, and so forth. The major part of the collection, however, reflects the efforts of Dr. Usinger, whose voluminous collecting in central Mexico with H. E. Hinton is responsible for the clarification of the previously confused taxonomic picture of this part of the generic range; where *Ambrysi* are available in large series, as they are from this region, the picture becomes one of simplicity; where only one or two individuals are at hand from a given locality, they contribute to confusion rather than clarity.

My best thanks are also due Dr. H. B. Hungerford of the University of Kansas, not only directly for the loan of specimens, but indirectly for being primarily responsible for the accumulation of what is undoubtedly the largest and finest *Ambrysus* collection in existence. To this end, he has spent time and money, over a period of many years, in the purchase and exchange of very desirable South and Central American material, and has also encouraged several fruitful expeditions to these areas which might not otherwise have come about.

The following persons have also aided me, by generously lending material from their private collections: Thomas J. Trelease of the Nevada State Fish and Game Commission; John W. MacSwain, Richard Coleman, Willis W. Wirth, and Robert J. Beer, all of the University of California at Berkeley; and Harry P.

Chandler of the California State Fish and Game Commission. Since the completion of the original thesis, I have been privileged to examine *Ambrysi* from the collections of the United States National Museum and of the University of Michigan and additional Usinger material. I also wish to thank Mr. Emil J. N. Ott III, senior biology student at the University of Nevada, for the photographs of *Ambrysi* which accompany this report, and the Standard Process and Engraving Company, Berkeley, for permission to use the base map reproduced in figures 1–12.

Abbreviations

The following abbreviations are employed to indicate the source and ownership of the material examined: CAS = California Academy of Sciences, LaR = the writer, MCZ = Museum of Comparative Zoology (Harvard), RLU = R. L. Usinger, UK = University of Kansas, UM = University of Michigan, and USNM = United States National Museum.

Structural Characters

The major difficulty in the study of *Ambrysus* in past years has been the almost complete lack of definition of significant morphological details. In spite of the existence of good structural characters, previous specific delineations have been made almost entirely on the "more or less" level. This terminology has rendered of little value such keys as have been published. My first impression of the genus, gained largely from the literature, led me to suppose that no substantial differentiates existed, and that the group was badly overworked.

A preliminary survey of the large amount of material gathered for this study, however, soon dispelled any doubts about the weaknesses of the described categories in the group. It was quite apparent that good morphological differences existed in abundance, none of which had ever been utilized in keys, and few of which had even been mentioned in the sometimes quite lengthy descriptions of species in the literature. The external morphology of *Ambrysus* is considerably more complicated and extensive than hitherto recognized; nevertheless, the differentiating characters are so good that simplicity rather than complexity is served, and the picture, as now understood, becomes intelligible both phylogenetically and geographically.

The chief failure of Montandon, the onetime leading authority, to grasp the phylogenetic pictures was due to his exclusive dependence upon the dorsum for taxonomic characters, whereas, in reality, the great majority of good differentiates involve ventral details.

The systematics of *Ambrysus*, as developed in this essay, are based almost without exception upon these ventral details and upon the external male and female accessory genital structures. In terms of their relative importance to this system, they are:

1) The relation of the propleura (*a*) to the prosternum and (*b*) to each other. (*a*) The propleura may be either rigidly fused with the posterior end of the prosternum or entirely free from it; if they are free the posterior slope of the prosternum descends beneath their anterior median edge. This latter character, from present indications, seems to be of almost subgeneric significance. (*b*) The propleura vary considerably in their manner of union with each other along the

median line, from being widely separated, with ends rounded, to being firmly and broadly united, with all types of intergradation.

2) The character of the ventral, distal, transverse metatibial spination. This has been found to provide consistent differentiates on a species-group level, the number of such rows varying from one and a fraction (in the majority of species) to a maximum discernible number of eight rows, each row decreasing in length proximad.

3) The male internal genitalia and external accessory structures and the female external subgenital plate are of great importance, the former being principally of group value, the latter usually only of specific importance. The only structures of the male internal genitalia of taxonomic significance are the two basal edeagal plates, which vary from simple, almost rectangular plates, to U-shaped structures. The important accessory external structure in the male is the chitinous flap or hook (referred to in this report as the *male process*) usually present on the caudal margin of the fifth tergite, on the right of the median line. This process varies greatly in size, shape, and proportions, and in a small number of species it is entirely absent.

The female subgenital plate undergoes marked changes in the shape of the tip, from prolonged and almost pointed, to complexly bi-, tri- and quadrifid, and it is perhaps the most important single basis for the species concept in *Ambrysus*.

4) The proportion of serrated to nonserrated connexival abdominal margins and the nature of such serration or dentation are important in separating one very prominent group of species from the remainder of the genus (*pudicus* group).

Color patterns, although often well developed, are of little systematic value, because of their complete intergradations and the difficulty of exactly defining them. Relative proportions are seldom used, and degrees of convexity, ovality, and robustness or slimness, previously so popular with workers in *Ambrysus*, are here discarded as of little worth in any system which purports to delineate species so that others may recognize them.

HISTORY

In 1862, the talented Swedish hemipterist Carl Stål described the genus *Ambrysus* and the species *pudicus, melanopterus,* and *signoreti*. In 1876 he added *puncticollis* and *guttatipennis*. *A. puncticollis* was from Texas, the other four species from Mexico. The large and varied South American reservoir of the genus, as well as the many additional North and Central American species, remained virtually untapped until the Rumanian A. L. Montandon began work on them more than twenty years after Stål. The only interim worker was the Argentinian Carlos Berg, who described *A. fucatus* from the Argentine in 1879.

Montandon, over a period of some fifteen years, described as many species in the genus as had all other workers combined, before or since his time, publishing in French in various European journals. The difficulties raised by Montandon's method of treatment have been mentioned in the introductory material. Between the years 1897 and 1910 he described a total of twenty-three species from the New World, few of which can be separated from one another, or can be more than tentatively placed by means of his keys and descriptions, but most of which seem to be good, nevertheless.

Thirty-six years elapsed between the cessation of Montandon's work and the publication by Usinger, in 1946, of sixteen new species in the genus. The only interim consideration of the genus was that by Hungerford in 1919; in that year he included a summary of the United States species in a work of larger magnitude on the biology of aquatic Hemiptera in this country, translating Montandon's key into English. During this long period, Dr. Usinger was accumulating material for a future review, aided by Dr. Hungerford, and the unworkable nature of the Montandonian keys and descriptions, as well as the inaccessibility of his types, seems to have effectively discouraged other potential workers. The Usingerian species were all from north of Panama, except the Peruvian-Ecuadorian *A. fossatus*, and were the result of a comprehensive analysis of the largest *Ambrysus* collection that had been brought together up to that time.

The early literature on *Ambrysus* in North America is replete with misidentifications. As an example, all previous records of *A. signoreti* in the southwestern United States belong to a species to be described in the present report, and the true *signoreti* of Stål seems to be restricted to central Mexico, the locality from which it was originally described. The eminent American hemipterist, Philip R. Uhler, is the source of most of these early records, and it is evident that his concept of *Ambrysus* was quite at variance with what we now know of the group.[1] This is attested by his recording (1894) of *A. pudicus* Stål from Baja California, where it has never since been found; there is no doubt that he was confusing *pudicus* with the then undescribed *A. hungerfordi* Usinger, which is quite distinct as we recognize it today, the resemblance being only superficial. Our knowledge of this segment of *Ambrysus* has progressed to the point today where we can recognize a *pudicus* group, composed of the distinct species *pudicus, hungerfordi, parviceps* Montandon, and a fourth species to be described later, where previously only a single entity was recognizable. Similar situations prevail in many other sections of the genus. This segmentation has not been accomplished by excessive attention to minutiae or by artificially raising variants to specific rank, but by the detection of previously unused and, if we may judge from their complete absence from early descriptions and keys, unsuspected characters of specific value in the external male and female genitalic accessories.

Apparently the first written mention of the male process on the fifth tergite is that of Hungerford (1919). His notation is easily overlooked, however, since it is in the small explanatory text accompanying a plate in the back of his paper: "Another character in this group [*Ambrysus*] that may have possibilities is a chitinized flap that is present on the margin of one of the latter abdominal tergites. Its position is on the right side in the material of the two species examined [*A. melanopterus* and *A. signoreti*] and distinctly different in shape." Neither this male process, which is of prime importance in the taxonomic structure of the genus, nor the key morphological details mentioned above in the introductory matter—except for Usinger's utilization of the prosternal-propleural relationships in certain of his 1946 descriptions—have been mentioned in the literature subsequent to Hungerford's notation, except in my isolated description of *A. funebris* in 1949.

[1] An interesting example of his early conception of the Naucoridae is Uhler's use (1876) of this family name for the belostomatids *Abedus ovatus* and *Belostoma fusciventris* (then in Zaitha).

GEOGRAPHY

The total known distribution of *Ambrysi* extends from a northern line connecting Yellowstone National Park, in northwestern Wyoming, and the Black Hills, in southwestern South Dakota, southward to an as yet indeterminate section of Argentina. In the United States, where the group is best known, it is restricted to the topographically irregular western half, giving way in the eastern part of the country to the genus *Pelocoris* of a different subfamily (Naucorinae). It is unfortunate, in light of the possibilities presented by the distribution of the genus for adding to our knowledge of animal geographics, that I am able to record so few facts about the actual, specific limits of distribution of any of the species concerned. However, enough collecting has been done in central Texas and adjacent Mexico to indicate the pattern of distribution in this section. Records of *Ambrysi* from northeastern Mexico suggest that the genus is not found east of the Sierra Madre Oriental, the outlying foothills of that massive range forming the easternmost boundary; the semitropical lowlands between the mountains and the Gulf of Mexico seem exclusively occupied by *Pelocoris*. As one travels northward along the Sierra Madre to the Texas border, the picture becomes definite. Years of collecting in central Texas have shown that here the long, semicircular Balcones escarpment which borders the extensive Edwards Plateau on the south and east is the eastern boundary of *Ambrysus* in the United States. As in Mexico, the flatlands between the escarpment and the gulf are semitropical and are occupied only by *Pelocoris*.

The original tropical nature of the genus is hardly in doubt, on the basis of its present preferences and population and species climaxes, and it can be suspected that low temperatures may be the limiting factor in its northward spread, (1) particularly in view of the fact that the northernmost records (Yellowstone and the Black Hills) are from thermal waters, and (2) that the most widely distributed species, *A. mormon,* found from the Rockies to the Pacific, from nearly sea level to approximately 8,000 feet elevation and in waters varying from swift, pure mountain streams to quiet, brackish lakes, is an extremely variable species with two recognized subspecies and numerous unnamed ecads. The significance of *A. mormon* in this respect lies in the fact that, as the most variable species known in the genus, it is also the one which has penetrated farthest to the north. Apparently then, an increase in tolerance ranges for low temperatures over the tolerances of the group as a whole has been of considerable advantage to it, and other species, lacking such variability, have been kept farther south.

A. californicus bohartorum, the northern affiliate of the southern California *A. c. californicus,* another case in point, has managed to penetrate the coastal fog belt of northern California into an environment much more ameliorative than that a short distance inland, where low temperatures would presumably restrict its development.

In the Great Basin, the area in which *A. mormon* is most familiar to me, the species is subjected to perhaps some of the coldest temperatures in its entire range, and its environment ranges from fresh running water (Truckee River) to brackish lake water (Pyramid Lake). Both lie in regions of subzero temperatures and often other extreme winter conditions, but in water which seldom freezes.

Perhaps the one single datum of most significance geographically which was brought to light by the examination of this material is the fact that both South and North America[3] have separate *Ambrysus* faunae, neither of which overlaps the other, the Isthmus of Panama being the limiting area in both cases. The South American fauna is quantitatively less diversified than that of North America, but exhibits greater qualitative differentiation, one differentiate being the very closely allied genus *Melloiella,* the other the almost equally distinctive new subgenus *Picrops* of *Ambrysus.* However, the fact that the South American fauna is not quantitatively comparable to that of North America is not worthy of further comment, since it is quite certain that this is an apparent difference only, the result of unequal collecting in the two areas. From the qualitative differentiation, however, some further inferences can be made which seem to bear significantly on the geographics of *Ambrysus.*

The segregation of *Ambrysi* by continents seems to suggest quite clearly that the North and South American stocks of the genus have undergone extensive temporal and spatial isolation which must, from the degree of differentiation achieved, be admitted as of considerable antiquity. There can be little doubt, on this basis, that the physical separation of North and South America during most of the Tertiary was the chief operative factor in this mutual isolation; and since there is no evidence today that any mingling of continental stocks has taken place with the union of the two land masses, it may be assumed that the present rain-forest cloak over the Panamanian isthmus is as effective a barrier as the Tertiary waterway. It thus seems evident that the roots of *Ambrysus* as a recognizable entity antedate the Eocene, and possibly the Paleocene, going back to the very early Tertiary or pre-Tertiary union of North and South America in order to allow the genus its first access to both continents, irrespective of which land mass future evidence may point to as its point of origin.

PALEONTOLOGY

The genus *Ambrysus* is unknown in the fossil record, and the status of the family in the Western Hemisphere is hardly more definite. In 1890, Scudder described and figured a fairly complete Florissant hemipteran as "Discostoma? sp.," referring it quite positively to the subfamily "Cydnida" of the Pentatomidae. His use of *Discostoma* was new, the name replacing *Lobostoma* Am.-Serv., preoccupied in Mammalia, and his assignment of it is without question: "This name is proposed for *Lobostoma* . . . The genus is composed of only two or three species found in Central America and Guiana. It has never been recognized in a fossil state, and the specimen from Florissant is referred to it only tentatively until better material is at hand."

In 1908, Handlirsch placed the fossil in the family Naucoridae without attempting to rename it. Judging from Scudder's illustration of the fragment, Handlirsch's assignment is the correct one, but it has not yet been possible for me to reëxamine the specimen.

Scudder's 1890 report on Tertiary insects of North America is concerned mainly with the great mass of material from the Green River lake deposits[8] of Utah and

[3] Including Central America.

[8] Upper Wasatchian to Lower Bridgerian in age (= Lower to Middle Eocene).

the Florissant Lake beds of Colorado,[4] all disposed of with the blanket term "Tertiary." Latest authoritative opinion on the paleoecology of these deposits suggests that the Green River strata, laid down over an area of approximately five thousand square miles, "indicates a warmer climate than that in the lower Eocene—a mixture of warm-temperate and tropical elements" (Stirton, 1948)[5] on the basis of its flora. As pointed out by Dr. Stirton, additional variety in the ecological situations extant during this time is indicated by the cactus *Eopuntia douglassi,* described in 1944 by Chaney from the Green River deposits, the inference here being that a desert environment may have existed in this warm, humid region, possibly in the rain shadow of one of the mountain ranges. Thus, since at our present stage of knowledge of *Ambrysus* we can postulate only low temperature as the possible northward-limiting factor, it is readily apparent that this factor could not have been a barrier to early Cenozoic naucorids—at least not in the vicinity of Green River in the Eocene.

In addition to Scudder's Florissant *Discostoma?* specimen, the only other fossil material mentioned in connection with the Naucoridae in North America is from the Green River. Scudder (1890) described *Necygonus rotundatus,* gen. et sp. nov., in the family Gelastocoridae (then Galgulidae), and was impressed with its possible affinities with the Naucoridae:

> It shows certain resemblances to Aphelocheirus, but on the whole seems rather a member of this family [Galgulidae] than of the Naucoridae.
>
> This genus differs markedly from Pelogonus, to which it appears to be most nearly allied, in the great length of the forelegs, which seem to show a relationship to the Naucoridae, though they are in no sense raptorial.

Handlirsch (1908) placed the species in *incertae sedis,* and recourse to Scudder's figure of *N. rotundatus* tends to substantiate Handlirsch's action; the fossil is very fragmentary, consisting only of head, pronotum, fore- and midlegs, and proboscis, none of which show, to my mind, any affinities whatever with naucorids. The much more promising and recent Rancho La Brea, Carpinteria, and McKittrick deposits of California (late Pleistocene) have yet to be investigated; but the prevalence of *Ambrysus* in southern California today leaves little doubt that a thorough search will produce specimens in these deposits.

As nearly as structural variations in *Ambrysus* can be evaluated at the present time, the group gives strong indications of being quite ancient. The segregation by continents of units of *Ambrysus* on the group level (discussed above under Geography) is further evidence of group antiquity and is not incompatible with what we already know with much clarity from the mammalian picture. The antiquity of the family Naucoridae itself is quite pronounced and well established. Handlirsch (1908) records *Paleoheteroptera lapidaria* (Weyenbergh), 1869, from "Solnhogen in Bayern. Lithogr. Kalk. Malm" and *Nepidium stolones* Westwood, 1854, from "Ridgway in England. Unteres Purbeck. Malm," from the Upper Jurassic of Europe.

BIOLOGY

Most of the available information on *Ambrysus* biology is that worked out by Usinger, who has published only a small portion of his findings. Hungerford had

[4] Orellan (= Middle Oligocene).

[5] Unpublished data and personal communication.

previously (1919) reiterated Uhler's observations: "Uhler says that *Ambrysus signoreti* dwells in the quiet waters adjacent to streams and in standing pools, especially such as are grassy. Another species is found in ponds in Dakota. No one seems to have noted the eggs or other biological matters concerning these insects."

Usinger's published studies of *Ambrysus* are concerned only with *A. mormon* from central California (Usinger, 1946):

> *Mormon* occurs typically in streams with pebble bottoms . . . The bugs swim about amidst the pebbles, searching for their prey which includes various aquatic larvae. They prefer quiet or slow-moving water along the edges of streams, but may swim out into deeper water where the current is swift.
>
> Eggs are glued to the surface of pebbles. They are laid by over-wintering females during the spring and early summer. They are suboval in form with a small buttonlike micropyle at the anterior end. When first laid they are creamy white in color. After about a week the color changes to gray and reddish eye spots can be seen through the chorion as development progresses. Hatching occurred within 47 to 52 days at Berkeley where it is cool during April, May and June and within 25 to 33 days at Davis where temperatures are much higher. Hatching occurs by bursting a crescent shaped tear at the micropylar end of the egg.
>
> The length of nymphal instars was determined in the laboratory at Davis during May, June and July. Average figures are given. First instar is 13 days, second 12 days, third 14 days, fourth 15 days, and fifth 22 days.

I have had some measure of field experience with only two species, *A. mormon* and *A. funebris*. My best acquaintance with *A. mormon* is in the western Great Basin, where it lives under a variety of conditions. Its most unusual habitat, apparently, is Pyramid Lake, a brackish, tectonic, euendorheic lake in western Nevada, the oldest surviving remnant of Pleistocene Lake Lahontan. Most of the water in Pyramid Lake comes from the Truckee River, the outlet of Lake Tahoe, in the Sierra Nevada. Because of decreasing intake, the level of Pyramid Lake has been dropping and the lake waters are becoming increasingly more brackish. The latest salinity figure available is 0.35 per cent, or approximately one-tenth that of sea water (La Rivers, 1946). In such an environment, *A. mormon* is the dominant insect, sharing with the common dragonfly *Ophiogomphus morrisoni* the gravel beaches and the protection of tufa fragments, and it is second only in numbers to a small species of *Gammarus*. Since the lake gives all indications of continuing to increase in salinity, the opportunity to investigate critical tolerances of *A. mormon* to salt concentrations may arise, but at present the species is thriving. A companion lake, Winnemucca, that had a depth of eighty feet of water some thirty years ago, has been dry for approximately twelve years—it went through an entire cycle of filling and emptying in a little less than a hundred years.[6] At its high-water mark, Winnemucca Lake was nearly as long as Pyramid Lake (approximately thirty miles long) but much narrower. Unfortunately, no data are available concerning the rise and fall of the *Ambrysus* fauna of the lake.

Specimens of *A. funebris,* a small and peculiar type, have been found only at the type locality, a warm, small, highly mineralized stream near Furnace Creek (Cow Creek). Here they occur in such numbers that *A. funebris* can be considered the dominant animal, although dragonfly and damselfly naiades are also abundant.

[6] Winnemucca Lake apparently was an empty playa when Frémont passed near it in 1844.

The water is approximately 36° C. and is swift throughout most of its course. Where the stream widens or is dammed, and consequently decreases in speed of flow, fine silt forms which seems to preclude *Ambrysi*. Conversely, where the flow is swiftest and the bottom swept bare of all sand and gravel, *A. funebris* are also absent. But in intermediate areas, where the flow may be rapid but not of sufficient force to remove gravel, *A. funebris* are found in large numbers, crawling about among the sand-free gravel pebbles. Although they can swim moderately well in still water, they probably swim very little in their native stream, since they seem quite helpless to stem the current if forced to swim—they are, however, very agile and adept crawlers. In some locales, *Ambrysi* seem to be mainly creepers among pebbles and vegetation and bottom crawlers, but in other places they appear to make up a dominant part of the actively swimming fauna. When hunting, *A. funebris* crawl about on gravel, searching industriously and meticulously for prey: when so occupied, they strongly resemble small scorpions in the manner of holding the large, incrassate forefemora out in front, with tibiae pointing straight ahead, ready to clamp fast to any living object encountered. Once clamped to an object, they hold on with great tenacity. But they seldom molest each other, even when crowded together, and when one accidentally engages another *Ambrysus* it soon recognizes its mistake. Their vision seems poor; those observed never gave any indication of seeing even violent motion more than two body lengths away but readily responded at shorter distances. They are not particularly swift in making a capture but seem to depend upon catching animals which they can blunder upon easily.

PHYLOGENY

As suggested in the discussion of geographics, South America seems to offer the best evidence of an ancestral home for *Ambrysus*. This appears evident largely on the basis of the greater qualitative differentiation which has occurred there. The most closely allied genus, *Melloiella*, a large, peculiar, monotypic unit (*M. truncaticollis* De Carlo, 1940), is known only from a rather small, indefinite area of southern Brazil; the greatest divergence among members of *Ambrysus* itself also occurs in South America. The new monotypic subgenus *Picrops* has been found only in a small area of northern Brazil—southern Guiana—and is the most unique single unit of the genus.

The fact that the North American fauna gives every evidence of possessing a vigorous evolution potential[7] indicates to me that there are no valid grounds, on the basis of our present knowledge of the genus, for supposing that the greater qualitative segregation exhibited in South America is due to a stronger evolution differential there. In fact, as I interpret the data at the present time, the most obviously modern elements in *Ambrysus* are confined to North America, whereas the South American fauna seems largely antique.

At this point, it seems expedient to develop the phylogeny and classification here used in a natural sequence from primitive to modern, separating each natural group from the basic stem as it comes up for consideration. In effect, this amounts

[7] The great number of scarcely distinguishable entities which flourish today in Mexico and the southwestern United States in response to the multitudinous habitats furnished by the topographic irregularities of the region is a case in point here.

to reviewing the genus in order from the units qualitatively most differentiated to those least differentiated. For comparative purposes, significant elements of Montandon's treatment of these groups in his keys, so far as he recognized them, will be included.

Ambrysus (*Picrops*), a monotypic subgenus, was unknown to Montandon, therefore has no cognate in his keys. It separates quickly from the remainder of the genus, *Ambrysus* (*Ambrysus*), by the possession of more than three distal, transverse series of short spines on the ventral surface of the hind tibiae. Moderate magnification readily reveals at least five such rows, each row decreasing in length (across tibia) proximally—under higher powers, a total of eight such series can be detected, the eighth usually only a single spine but obviously a part of the proximally decreasing series. In addition, on the sixth sternite the male exhibits a short, lateral process which has no counterpart in the subgenus *Ambrysus*. The female external genitalic picture is not distinctive.

The subgenus *Ambrysus* separates into two quite distinct entities, depending upon whether the posterior, sloping portion of the prosternum is fused with the adjacent edges of the propleura (division *Coalescens*) or is free from the propleura and disappears beneath the anterior median propleural edges (division *Disjunctus*). The former is a small unit, containing only the two species groups *oblongulus* and *planus*, the latter being monotypic and another example of the greater qualitative segregation in South America. This fusion of propleura and prosternum is distinctive also of the subgenus *Picrops* and the genus *Melloiella;* much reliance is placed upon it in this phylogeny as a key indicator of basic relationships—there are no approaches to this condition anywhere else in the genus *Ambrysus*. It must be admitted, however, that the groups *oblongulus* and *planus,* as judged by other characters, have diverged considerably and must be placed at opposite ends of the division *Coalescens,* although there is no present indication that this is an unnatural association. This point of view has, however, some interesting implications.

As previously stated, the North American and South American *Ambrysus* faunae are distinct entities; none of the recognized groups have representatives beyond the limits of their respective land masses. Actually, the only evidence we have at the present time that such faunae have an actual thread of unity is at the group level and involves *Coalescens. Ambrysus planus* is known only from a restricted area in parts of Peru and Ecuador; the *oblongulus* group is entirely North American. Thus, each of the two units in *Coalescens* is now a member of a different fauna. From the degree of cleavage between the two on other characters, this separation seems obviously of great antiquity and is compatible with what we know of the long Tertiary isolation of North America and South America.

Montandon recognized the *Coalescens* division *per se* (except *planus,* which he did not know), but not on the basis of the all-important prosternal characters. Even though the *oblongulus* group is easily separable visually from other *Ambrysi,* the differences are comparative and are extremely difficult to explain in print. Montandon characteristically expressed this difference as "Échancrure antérieure du pronotum assez profonde . . . ," a statement which was designed to separate the group distinctly from other *Ambrysi,* which were characterized as "Échancrure antérieure du pronotum plus obtuse . . ."

In the division *Disjunctus,* including the remainder of *Ambrysus,* a consideration by faunal areas seems to follow the natural order and satisfactorily bring out the phylogenetic sequence.

Considering the smaller South American fauna first, three species groups are apparent, *stâli, fossatus,* and *fucatus. Stâli* stands apart by virtue of its possession of three distal, transverse, ventral metatibial rows of spines, *fossatus-fucatus* having but two such rows. *Stâli* was unknown to Montandon; the only elements in his keys of these three species groups were *A. bergi* and *A. ochraceus,* which he separated from other species by "Angles antérieurs du pronotum très proéminent, aigus," the remainder of the dichotomy being "Angles antérieurs du pronotum moins proéminents, presque droits, a peine aigus"! The groups *fossatus* and *fucatus* are closely allied, and examination of representative material from intervening areas may result in their classification as one group.

The remaining known species are North (including Central) American. Among the species groups north of Panama (*oblongulus, melanopterus, puncticollis, pudicus, pulchellus, californicus, vanduzeei,* and *signoreti*), the most distinctive element is *melanopterus* (monotypic), which shows faint traces of relationship to *puncticollis* (also monotypic) but is otherwise a well-isolated unit. Its known distribution ranges from the southwestern United States to Guatemala, while *puncticollis* occurs from the southwestern United States to central Mexico. *A. melanopterus* is readily separable from all *Ambrysi* by the broad junction of the propleura along the median line directly posterior to the prosternum, a junction which is approximately equal to the length of the prosternal keel between the procoxae; all other *Ambrysi* have the prosternal keel considerably longer than the junction of the propleura, *A. puncticollis* approaching *A. melanopterus* most closely in this respect.

The *pudicus* group is an extensive union of several entities, all known specimens being from Mexico. The species are small, rotund, quite distinctively pilose laterally, and most readily separable as a group by virtue of the type of serration on the connexival edges of abdominal segments three and four (III and IV), in contrast to the perfectly smooth connexival edges of segments I and II. This combination is unique in the genus, and this is the only North American group in which some of the males have lost all traces of the otherwise diagnostic genital hook or process on the fifth tergite; a series of species exists here grading from those lacking hooks to those with short, definite processes. The only other loss of the male genital process occurs in the South American *A. planus* and *A. usingeri.* Montandon knew only *A. pudicus* in the group and separated it from other species as "Tête très sensiblement plus etroite, yeux compris, que la moitié de la largeur du pronotum en arrière . . ."

The remaining four species groups of the North American fauna fall into two weak divisions, depending upon whether the propleura are fused or touching along the median line behind the prosternum (*vanduzeei* and *signoreti*) or gape apart (*pulchellus* and *californicus*). This character requires further testing with larger numbers of specimens, but at present it has some reliability. At the present time, it is somewhat uncertain whether this association of *pulchellus* with *californicus* is the correct interpretation of their relationship; it is possible that the *pulchellus*

group is more isolated than this arrangement indicates. If so, it can be set apart on the evidence furnished by the extremely narrow, impunctate pronotum (expressed as combined length of pronotum plus head being more than two-thirds of the greatest pronotal width).

Montandon's most definite couplet involves the *pulchellus* group, which he separated as "Tête très large, aussi large, yeux compris, que la moitié de la largeur du pronotum en arrière," the alternate being "Tête tres sensiblement plus étroite, yeux compris, que la moitié de la largeur du pronotum en arrière."

The monotypic *vanduzeei* group is apparently a peculiar derivative of the *signoreti* complex, and is known only from the peninsula of Baja California, Mexico. It is immediately recognized by the very distinctively developed female subgenital plate—long and semitubular, extending beyond the end of the abdomen. Differences in the male genital process indicate that the species deserves group status. Nothing is known of the biology of *A. vanduzeei,* but the comparative sharpness and elongation of the female subgenital plate suggests a possible adaptation for inserting eggs into plant tissues—all other known *Ambrysi,* with the possible exception of *A. ochraceus* in South America, seem to merely attach the eggs to the surfaces of various objects. Montandon did not know the group.

The *californicus* group is composed of a small, somewhat oval species known only from the region of the west coast of the United States, quite close to the *signoreti* complex. At present, it is readily separable from *signoreti* by the gaping propleura, but this character may weaken and disappear when the latter group is more fully known, for some of its species have propleura which are not fused but merely touch. The single species *A. californicus,* segregating into a northern subspecies, *A. c. bohartorum,* and a southern, *A. c. californicus,* constitutes the group *californicus.* The species was described by Montandon, who did not know the northern unit, and he separated it from other *Ambrysi* with "Taille petite, au dessous de 8 mm.," the alternate being "Taille plus forte, au dessus de 9 mm. de longueur." He placed it between *A. pudicus* and *A. melanopterus.*

The remaining group, *signoreti,* is the most complex unit of the entire genus and the largest in point of species. Seemingly the most distinctive element of the complex is *A. mormon,* which breaks up into three geographical races and numerous unnamed ecads. It is the commonest United States species and barely penetrates southward into northern Mexico. It is most satisfactorily separated from the remainder of its group by the shape of the female subgenital plate tip, which has a definite and typical concavity, and by the shape of the male genital process, which is slim and narrow. *A. mormon* represents the northernmost unit of the entire genus, a thermally modified ecotype being known from Yellowstone in northwestern Wyoming, and seems to be only a slightly altered temperature-adapted segment of the *signoreti* complex. Most *Ambrysi* I have seen from thermal waters in the United States are obviously *A. mormon* types; ecologically, the problem whether these represent ecotypes or merely ecads is a somewhat complex one and not easily settled. Taxonomically, the solution is much simpler, since both ecotypes and ecads can be conveniently expressed only as subspecies, unless one wishes to revive the four-headed spectre of quadrinomialism. There is some chance that such entities may be accorded specific standing, depending upon the concept

of the worker; in any event, it is quite clear that much additional material will be needed and much additional field work must be accomplished before any conclusive evidence will be available. Montandon never characterized *A. mormon* in a key; he described the species after the last of his keys was published.

The remainder of the *signoreti* group, difficult on purely technical grounds to sharply characterize, nevertheless displays a homogeneity of form and coloration which is unmistakable. There is considerable variance in the terminal outline of the female subgenital plate as well as in the shape of the male process. Four rather well-defined subgroups of species are indicated among the material assigned to the group, but since they are nearly at the specific level of differentiation, they will not be discussed here.

As previously suggested, it is seemingly correct to ascribe the wide variety exhibited by members of the *signoreti* complex in the southwestern United States and northern Mexico to the great environmental diversity of the region, a discongruity directly due to the geomorphologic irregularities which provide sharp zoning effects in climate and direct physical barriers that restrict water systems and produce such unusual situations as can occur only in thermal waters of various types in regions of interrupted drainages. Where this diversity is lacking, speciation is likewise lacking, an example of this latter condition being that of *Pelocoris* in the more topographically monotonous eastern United States.

SYSTEMATICS

Family NAUCORIDAE (Fallen, 1814)

Subfamily AMBRYSINAE Usinger, 1941

Genus AMBRYSUS Stål, 1862

(Logotype *signoreti* Stål)

Ambrysus Stål, 1862, Stet. Entom. Zeit., 23: 459; 1865, Hemip. Afr., 3: 174; 1876, Enum. Hemip., 5: 141, 143.

Ambrysus, Uhler, 1872, Hayden's Surv. Terr., Rept. for 1871: 423; 1876, Bull. U.S.G.S., 1: 337; 1877, Wheeler's Rept. Chief Eng. for 1877: 1331; 1884, in Standard Nat. Hist., 2: 249, 260; 1886, Brooklyn Entom. Soc.; 1894, Proc. Calif. Acad. Sci., Ser. 2, 4: 291.

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Ambrysus, Snow, 1906, Trans. Kans. Acad. Sci., 20 (1): 180.

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Ambrysus, Hungerford, 1919, Bull. Univ. Kans., Sci. Bull., 11: 198.

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Ambrysus, La Rivers, 1949, Bull. So. Calif. Acad. Sci., 47 (3): 103; 1949, Ann. Entom. Soc. Amer., 41 (3): 371; 1950, Pan-Pac. Ent., 26 (1): 19.

Until Usinger established the subfamily Ambrysinae for the genera *Ambrysus*, *Melloiella*, and *Cataractocoris*, *Ambrysus* was considered part of the subfamily Cryptocricinae (Cryphocricinae). The genus may be modernly characterized as:

General appearance.—Small and rotund to large and ovate, 6–15 mm. long, 3.5–8.0 mm. wide. Dorsum generally distinctly bicolored, head and prothorax slightly lighter in color than remainder, emboliar edges usually lighter than hemelytra, the latter with or without mottling. Venter generally lighter than abdomen, darkening somewhat in anterior half of body, with or without median, anterior mottling.

Head.—Glistening and impunctate to roughened and strongly punctate, greenish, yellowish, brownish or combinations of these colors, varying from smoothly curved between the eyes to distinctly protuberant before eyes. Eyes generally much darker in color than head, brownish to black, in pinned specimens often drying to a pearly gray; outer and posterior margins either forming a continuous curvature or producing an angulation at point of contact. Labrum same color as front of head, or darker; mouthparts generally darkening at tip.

Pronotum.—Varying from nearly impunctate and glistening to rough and strongly punctate, and in color from greenish, through yellow, to deep blackish brown. Combined length of pronotum and head varying from more than two-thirds greatest pronotal width, to distinctly less than two-thirds such width. A thin, transverse, dark posterior pronotal line prominently present, the remainder of the posterior pronotal border behind the line predominantly whitish in color. Lateral pronotal edges varying from evenly curving caudad to nearly straight; also varying from smooth to serrate. Posterior pronotal angles may be lacking (i.e., well rounded) or sharply prominent. Venter generally darker medially, with yellow pile prominent about centrum and posterior edge.

Scutellum.—Always strongly shagreened with shallow but dense punctations, each puncture whitish at bottom. Coloration varies from unicolorous dark brown to various mottlings of light brown and yellow, in some cases, predominantly yellow.

Hemelytra.—Nearly always with some glisten, punctate, each puncture the seat of a white spot, varying in color from unicolorous dark brown to a well-developed mottled pattern of brown and light, bright yellow, the embolium almost always distinctly and conspicuously lighter than the rest of hemelytra. Hemelytra may strongly or weakly expose the lateral connexival edges, and may or may not attain abdominal tip.

Venter.—The prothoracic venter has been discussed above. The remainder of venter is generally distinctly bicolored, the abdomen golden to brown because of the short, golden hydrofuge pelt, and lighter in color than the velvety-appearing meso- and metathoracic venters, which latter may have rich brown mottling centrally. Connexival segments may exhibit various combinations of spination or nonspination on the posterolateral angles; if spined, the first, and often the first and second, angles are generally nonspinose.

Legs.—Prolegs: Coxa elongate, globular, green, yellow or brown, smooth, glistening, darkening at distal tips, flattened to receive the heel of femur. Trochanter well developed as a segment between coxa and femur, smooth, green, yellow, or brown, with tufts of yellow hairs on anterior edge. Femur smooth, glistening, green, yellow or brown, widest near proximal end, narrowing rapidly to distal end, and with characteristic short, very dense mat of hairs along front border which serves as a resting groove for the tibia when closed against femur, latter characteristically incrassate and compressed dorsoventrally. Tibia very long, slender, smooth, yellowish to brownish, occasionally greenish, curved most strongly in distal part where, with the single tarsal segment, it forms a continuous, curved, grasping instrument—combined tibia-tarsus (with claw), when closed, either slightly longer or slightly shorter than adjacent edge of femur.

Mesolegs: Coxa long, greenish, yellow, or brownish, somewhat angularly globular, beset with short, dense, golden pile, slightly curved from posterior end weakly laterad to anterior end, the outer face flat for the reception of the basal part of the femur. Trochanter larger, distinct, similar in color to coxa, smooth distally, pilose proximally. Femur very long, narrow, smooth, similar in color to coxa, glistening, compressed dorsoventrally, some golden pilosity on outer edge. Tibia greenish, yellow, or light brown, smooth, glistening, narrow, strongly armed with longitudinal rows of strong, reddish-brown spines, arranged in series along the four rounded "angles" formed by the slight dorsoventral compression of tibia—distal end ventrally with from one and one-half to a maximum of eight transverse rows of spines set across width of tibia, the

last row at extreme distal tip. Tarsus slender, smooth, glistening, greenish to yellow, pilose beneath, three-segmented, the first segment minute and difficult to see, even in ventral view, terminating in two claws of about same color as tarsus, darkening at tips, generally weakly curved.

Metalegs: Coxa swollen, globular, green, yellow to light brown, well haired with short, dense golden pile, flattened ventrolaterally for reception of basal part of femur. Trochanter well developed, similar in color to coxa, pilose proximally, smooth and glistening distally. Femur long, narrow, smooth, glistening, green, yellow, or brown, dorsoventrally compressed, weakly spinulose along outer margin and bearing a thin mat of short, yellow pile on inner margin. Tibia long, narrow, glistening, yellow or green, thickly beset with brownish-red spines as in mesotibia, but spines longer, more prominent, and more evidently unequal in size, long and short spines alternating, arranged along four "corners" formed by the slight dorsoventral flattening—distal end ventrally with from one and one-half to a maximum of eight transverse rows of spines set across width of tibia, the last row at extreme tibial apex—inner margin cushioned with a solid, dense mat of long, silky, golden, swimming hairs. Tarsus slim, smooth, long, narrow, green to yellow, and brown, three-segmented (first segment difficult to see), spinulose and pilose beneath, with two claws markedly darkening at tips and weakly curved.

KEY TO THE SPECIES OF AMBRYSUS KNOWN TO OCCUR IN THE UNITED STATES

1. Prosternum fused to propleura, both on the same plane.................*circumcinctus*
   Prosternum free from propleura, most definitely so medially, prosternum medially disappearing posteriorly beneath fore edge of propleura..........................2
2. (1) Female with two elevated almost peglike angles arising from the caudal edge of sternite V at the lateral anterior edges of the subgenital plate; connexiva spineless; prosternal ridge subequal in length to union of propleura along median line; female subgenital plate tipped with a low, blunt angle; male genital process short, foot-shaped, strongly turned externally ....*melanopterus*
   Female lacking the two elevated angles on caudal edge of sternite V; species without the remaining combination of characters......................................3
3. (2) Female possessing a strong, broad, and rather blunt laterocaudal angle adjacent to the connexival angle of sternite V and medial to it; posterior slope behind median prosternal ridge with two tuberculations on each side of the median line directly behind caudal end of median ridge, producing a longitudinal median trough or indentation effect; male genital process large and strongly boot-shaped, the sole of the boot straight; tip of female subgenital plate broadly, weakly, and simply concave; large species, 13 mm. in length or more.................................*puncticollis*
   Female lacking such a laterocaudal angle; prosternal ridge and its posterior slope not constructed to produce a longitudinal trough or indentation effect; species without the remaining combination of characters.......................................4
4. (3) Males completely lacking a genital process or any indication of one, the point usually occupied by it being smoothly rounded; posterior prosternal slope with a transverse, darker tubercle situated medianly against caudal end of prosternal ridge and at right angles to ridge; smallest species known to me—length never exceeds 6 mm.... *funebris*
   Males always with a well-developed genital process; no tubercle on prosternal slope as described above; all species larger, none known to me less than 7 mm. in length....5
5. (4) Combined length of pronotum and head more than two-thirds greatest pronotal width; head and pronotum highly polished, smooth and glistening, without any evidences of punctation ....*pulchellus*
   Combined length of pronotum and head less than two-thirds greatest pronotal width; head and pronotum always with some discernible punctation, even though shiny......6
6. (5) Propleura gaping apart conspicuously at the median line in all specimens examined; female subgenital plate nearly straight across broad tip, generally only weakly sinuous near outer margins; male genital process narrow, parallel-sided, noncapitate, strongly bent toward the exterior...*californicus*
   Without the above combination of characters, propleura seldom gaping.............7

7\. (6) Female subgenital plate always prominently and conspicuously concave at tip, either simply or complexly so 8
Female subgenital plate always multisinuate (tri- to quadrisinuate) or more or less straight across tip, never concave 9

8\. (7) Female subgenital plate simply, broadly, and smoothly concave apically, the lateral bordering angles sharp; percentage of concavity, measured in terms of depth of concavity against length between bordering lateral angles, is never less than 20 per cent; in clean material, embolium nearly unicolorous, only very faintly lighter exteriorly, no contrasting colors present .... *buenoi*
Female subgenital plate, if simply concave, has (*a*) rounded lateral angles, or (*b*) if lateral angles are sharp, then depth of concavity is considerably less than 20 per cent; in clean material, embolium always sharply and contrastingly transversely bicolored, anterior two-thirds light yellow, posterior one-third blackish brown .... *mormon*

9\. (7) Apex of female subgenital plate deeply trifidly sinuate, the external angles, processes or sinuosities sharp, the central sinuosity rounded; male genital process narrowing to apex, strongly, abruptly, and almost right-angularly turned outward ...... *woodburyi*
Without the above combination of characters 10

10\. (9) Female subgenital plate distinctly and conspicuously quadrisinuate in outline at tip, the outer sinuosities rather blunt-angulate, the two median sinuosities low and about even with the line connecting the two lateral angles; male genital process slim, narrowing to apex, long and usually quite straight in contrast to most of the genus, occasionally slightly bent .... *arizonus*
With other combinations of characters 11

11\. (10) Apex of female subgenital plate more or less straight across the broad tip, the quadrisinuous condition barely detectable as a faint wavy line; male genital process short and broad .... *occidentalis*
Apex of female subgenital plate weakly quadrisinuate, but with the outer sinuosities much lower than the median sinuosities, which project caudally much more than the lateral or shoulder sinuosities; male genital process short and broad with the external angle of tip drawn out into a distinct elongated point .... *lunatus*

Ambrysus circumcinctus Montandon

(Pl. 1, *a;* fig. 13, *a*)

Ambrysus circumcinctus Montandon, 1910, Bull. Soc. Sci. Buc.-Roum., 19 (3) : 438.
Ambrysus circumcinctus, Van Duzee, 1916, Proc. N.Y. Entom. Soc.; 1917, Univ. Calif. Publ. Entom., 2: 458.
Ambrysus circumcinctus, Hungerford, 1919, Bull. Univ. Kans., Sci. Bull., 11: 201.

General appearance.—Rather small for the genus, slim, streamlined, 8–9 mm. long, 5.0–5.5 mm. wide. Dorsum bicolored, light anteriorly and laterally, dark posteriorly, entire surface punctate, more coarsely and shallowly so posteriorly, shiny. Venter darker anteriorly, lighter posteriorly, with mottling.

Head.—Yellowish brown, shiny, coarsely and shallowly punctate, prominent but smoothly protuberant between eyes. Eyes blackish, moderately protuberant above head surface, outer and posterior eye margins forming a smooth curve with no angular break in posterolateral region. Head moderately and widely set into anterior pronotal border. Labrum same color as head, or slightly darker, ratio of length to width, 21: : 34 (62 per cent); mouthparts darkening toward tip. Head ratios are:

1) Total length to width (including eyes), 59: : 86 (69 per cent).
2) Anterior distance between eyes to posterior distance, 40: : 55 (73 per cent).
3) Anterior distance between eyes to inner eye length, 40: : 32 (125 per cent).
4) Posterior distance between eyes to greatest length of head posterior to this line, 55: : 22 (40 per cent).

Pronotum.—Weakly shiny, yellow brown with vague, darker, longitudinal streaks, coarsely and shallowly punctate, extreme pronotal edge dark brown; thin, transverse, posterior pronotal line only faintly suggested, border behind it not conspicuously different in color from remainder of

pronotum; lateral edges with only a suggestion of microscopic serration, angles moderately curved from front to back, most of the curvature occurring in posterior half, the anterior half nearly straight—curvature, expressed in terms of straight-line distance between anterior and posterior lateral angles and greatest vertical distance between this base line and line of curvature, is 14–16 per cent (av. 88: : 13); posterolateral angles smoothly rounded. Venter yellow brown centrally, becoming blackish on lateral and posterior borders, golden pilosity conspicuous on latter edge; keel between prolegs ridged for approximately one-third of its length, falling off posteriorly in a moderately inclined, flat, plane surface; ratio of ridge length to keel length is 12: :40 (30 per cent). Dorsal pronotal ratios are:

1) Width between anterior angles to greatest width of pronotum (latter, in this case, is not synonymous with width between posterior angles, since these have been lost in the general rounding of the posterolateral pronotal region), 86: : 165 (53 per cent).

2) Median length to greatest width, 52: : 165 (32 per cent).

3) Distance between anterior angle and point of widest spread of pronotum on the same side to perpendicular distance between anterior angle and base line of pronotum, 79: : 82.

Scutellum.—Dark uniform red brown, becoming lighter at angles; minutely, roughly punctulate, each puncture the seat of a white spot; in normal position, i.e., approximately on a plane surface with remainder of body, ratio of three sides, anterior and two laterals, is 112: : 82: : 82.

Hemelytra.—Uniformly brownish black, coarsely and shallowly punctate, each puncture whitish at bottom; lighter along emboliar margins; embolium long, narrow (length to width, 100: : 25 = 25 per cent), shagreened, anterior third wider than is characteristic for the genus as a whole; embolium predominantly light yellow, in strong contrast to dark hemelytra, dark only posteriorly. Hemelytra markedly exposing lateral connexival edges, which are yellowish brown, without mottling, and with a dark-brown edge, which is nonserrate—connexivum IV in the male with posterolateral angle produced, IV and V in the female so produced, remainder nonspinose; hemelytra with a somewhat abbreviated aspect.

Venter.—The prothoracic venter has been discussed above. Remainder of venter bicolored, abdominal section bright golden yellow because of hydrofuge pelt, meso- and metathoracic venters slightly darker—a vaguely mottled, rich brown and yellow brown—emboliar venter similarly colored. Connexival segments I–III spineless, IV in the male angulate-produced, IV and V in the female angulate-produced; connexival edges blackish, smooth, or with a suggestion of serration on posterior segments; curvature weak but discernible, in some specimens an occasional malformation is suggested by an erratic, one-sided sinuosity developing along one of the edges, chiefly of one of the posterior segments. Female subgenital plate trifidly sinuate at apex, the central sinuosity occasionally broader, slightly truncate or even concave; male genital process moderately long, parallel-sided, noncapitate, blunt at tip, tipped uniformly approximately 45° toward the right side of the body from the median line.

Legs.—Prolegs: Coxa elongate, angularly globular, bright yellowish to brownish yellow, smooth, shiny, flattened to receive heel of femur, distal edges darker. Trochanter well developed as a segment between coxa and femur, smooth, shiny, same color as coxa, with a tuft of yellow hairs distally on anterior end. Femur smooth, yellowish, widest near proximal end, narrowing rapidly to distal end (i.e., typically incrassate), and with characteristic short, very dense mat of hairs along front border which serves as a resting groove for tibia when closed against femur, latter compressed dorsoventrally, ratio of length to greatest width of ventral surface of femur being 89: : 50 (56 per cent). Tibia very long, slender, smooth, shiny, same color as femur, curved most strongly in distal part where, with the single tarsal segment, it forms a continuous, curved, grasping instrument—combined tibia-tarsus claw, when closed, markedly overlapping adjacent (proximal) end of femur.

Mesolegs: Coxa long, yellowish, somewhat angularly globular, equipped with short, dense, golden pile, slightly curved from posterior end weakly laterad to anterior end, the outer face flat for reception of basal part of femur. Trochanter large, distinct, same color as coxa, smooth distally, pilose proximally. Femur somewhat stout for the genus, smooth, shining, yellowish, compressed dorsoventrally, some very short, sparse, golden pile on outer proximal end; ratio of length to median width of ventral surface is 86: : 20 (23 per cent); length, 2.1 mm. Tibia yellowish, smooth, shiny, comparatively stout for the genus, strongly armed with longitudinal

rows of strong, reddish-brown spines, arranged in series along the four rounded "angles" formed by the slight dorsoventral compression of tibia—distal end ventrally with two prominent transverse rows of spines set in a solid row across width of tibia, the last row at extreme distal tip—ratio of length to median width is 76:: 8 (11 per cent); length, 2 mm. Tarsus smooth, slender, shiny, same color as tibia but darkening at tip, pilose and setulose beneath, terminating in two claws, which darken at the tips.

Metalegs: Coxa swollen, globular, yellow, well furred with short, dense, golden pile, flattened ventrolaterally for reception of basal part of femur. Trochanter well developed, same color as coxa, pilose proximally, smooth and shiny distally. Femur long, comparatively stout for the genus, smooth, shiny, yellowish, dorsoventrally compressed, weakly spinulose along outer margin; ratio of length to median width is 100:: 16 (16 per cent); length, 2.8 mm. Tibia long, rather stout for the genus, shining yellow, thickly armed with reddish-brown spines as in mesotibia, but spines

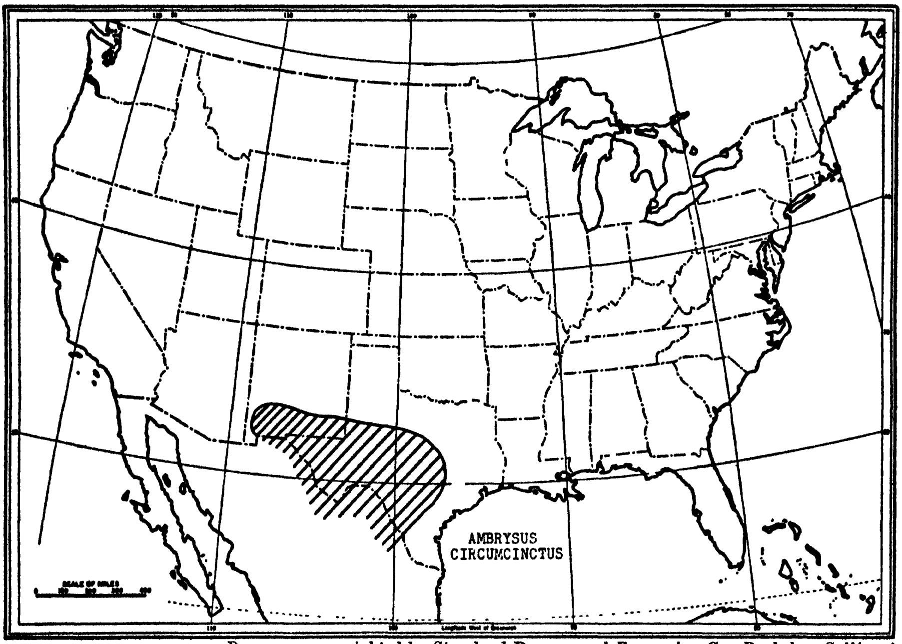

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Fig. 1. Distribution of *Ambrysus circumcinctus*.

longer, more prominent, and more evidently unequal in size, long and short spines alternating, arranged along four "corners" formed by the slight dorsoventral flattening—distal end ventrally with two prominent transverse rows of spines set in solid rows across tibial width, the last row at extreme tibial apex—inner length cushioned by a solid, dense mat of long, silky golden hairs; ratio of length to median width of ventral surface, 114:: 8 (7 per cent); length, 2.8 mm. Tarsus slim, smooth, long, narrow, same color as tibia, but darkening at tip, spinulose and pilose beneath, with the two claws weakly curved and darkening at tips.

Type locality.—"Kerville, Texas (F. C. Pratt colector) un seul exemplaire. U.S. N. Mus. Washington" (Kerrville).

Location of type.—United States National Museum.

Recorded distribution.—Texas.

Material examined (see fig. 1).—NEW MEXICO: Grant Co., Silver City, 22(vii)36, D. R. Lindsay (UK). TEXAS: Bailey Co., Progress, 1(vii)38, D. W. Craik (UK); Kinney Co., Pinto, 5(vii)38, D. W. Craik (UK); San Saba Co., San Saba, 1(vii)36, R. H. Beamer (UK); Uvalde Co., Concan, 6(vii)36, M. B. Jackson (UK); Val Verde Co., Del Rio, 8(vii)38, R. I. Sailer (UK); Devils River, 7(v)07, Schwarz and Pratt (USNM).

This is a small, distinctive, and seemingly rather common species, which undoubtedly occurs in adjacent Mexico. Very little has been written of this species; Hungerford (1919) translated and reprinted Montandon's original description. Nothing is yet known of the animal's biology.

Ambrysus melanopterus Stål

(Pl. 1, *b*; fig. 13, *b*)

Ambrysus melanopterus Stål, 1862, Stet. Entom. Zeit., 23: 459; 1876, Enum. Hemip., 5: 143.
Ambrysus melanopterus, Uhler, 1876, Bull. U.S.G.S., 1: 337.
Ambrysus melanopterus, Montandon, 1897, Verh. zool.-bot. Ges. Wien, 47: 12, 19; 1909, Bull. Soc. Sci. Buc.-Roum., 17 (5–6): 316.
Ambrysus melanopterus, Champion, 1900, Biol. Centr.-Amer., Heter., 2: 357.
Ambrysus melanopterus, Snow, 1906, Trans. Kans. Acad. Sci., 20 (1): 180.
Ambrysus melanopterus, Kirkaldy and Bueno, 1908, Proc. Entom. Soc. Wash., 10: 186.
Ambrysus melanopterus, Van Duzee, 1917, Univ. Calif. Publ. Entom., 2: 458.
Ambrysus melanopterus, Hungerford, 1919, Bull. Univ. Kans., Sci. Bull., 11: 201.
Ambrysus melanopterus, La Rivers, 1949, Bull. So. Calif. Acad. Sci., 47 (3): 108.

General appearance.—Rather slightly more than medium-sized for the genus, moderately slim and streamlined, 10–12 mm. long, 5.5–6.5 mm. wide. Dorsum strongly mottled anteriorly, unicolorous posteriorly; entire surface minutely rugose-punctulate, shining. Venter lighter posteriorly, darker anteriorly, with conspicuous blackening of edges in anterior half.

Head.—Shining, distinctly but weakly punctate, longitudinally streaked with alternate black-brown and yellowish stripes, the proportionate ratio of one to the other being quite variable, smoothly but distinctly protuberant between eyes. Eyes as dark as dark streaks of head, very slightly protuberant above plane surface of head; outer and posterior margins meeting at posterolateral corner of eye in a blunt but definite angle and not blending uniformly, smoothly, or evenly into one continuous curvature; basal or posterior eye margin conspicuously rimmed with a chitinous bar or raised edge which projects slightly laterad at posterolateral eye angle to form a weak but discernible angle, in marked contrast to other related members of the genus. Labrum deep reddish brown, ratio of length to width, 22: : 50 (44 per cent); mouthparts generally lighter than labrum. Head ratios are:

1) Total length to width (including eyes), 68: : 115 (59 per cent).
2) Anterior distance between eyes to posterior distance, 42: : 62 (68 per cent).
3) Anterior distance between eyes to inner eye length, 42: : 42.
4) Posterior distance between eyes to greatest length of head posterior to this line, 62: : 22 (38 per cent).

Pronotum.—Shining, shallowly punctate laterally, becoming weakly but distinctly transversely rugulose in anterior central portion behind deepest head penetration; color pattern generally distinctive, lateral edges narrowly pale yellow, inwardly bordered by a wider area of rich deep brown or black, this bordered in turn inwardly by a pale area well supplied with small, conspicuous, uniform, brownish-black spots which may coalesce at one or two places to form short streaks; the centrum is characterized by a V-shaped yellowish area occupied centrally by a dark-brown spot—two small, sharp, blackish spots occupy the base of the V; the thin, transverse, dark, posterior pronotal line is well defined, consisting chiefly of closely set black dots; remainder of posterior pronotal border behind line predominantly lighter in color, forming a unicolorous, pale band; lateral edges smooth, nonserrate, angles rather moderately curved anteroposteriorly—percentage of curvature, expressed in terms of straight-line distance between anterior and posterior lateral angles and greatest vertical distance between this base line and line of curvature, is 10–12 per cent (av. 128: :14); posterolateral angles distinct but rounded. Venter quite strongly bicolored, extreme lateral edge light yellowish, often with greenish tinge, replaced inwardly by a dark, velvety, rich black-brown area of triangular shape, widest anteriorly, which in turn gives way to a rich yellow centrum (turning red brown in dark individuals) which spreads posteriorly to occupy most of the posterior margin; sclerite edges with usual long, golden pilosity; keel between prolegs ridged for most of its length, falling off posteriorly in a very steep, black, flat

surface; ratio of ridge length to total keel length, 28:: 40 (70 per cent). Dorsal pronotal ratios are:

1) Width between anterior angles to width between posterior angles, 56:: 115 (49 per cent).

2) Median length to greatest width, 44:: 115 (38 per cent).

3) Distance between anterior and posterior angles on same side to perpendicular distance between anterior angle and base line of pronotum, 64:: 60.

Scutellum.—Black, same color as hemelytra, with no lightening of angles or edges; shiny, but roughly, minutely, densely punctulate, the base of each puncture whitish; in normal position, i.e., approximately on a plane surface with remainder of body, ratio of three sides, anterior and two laterals, 82:: 61:: 62.

Hemelytra.—Brownish black to black, shining, roughly, densely, minutely punctulate, the base of each puncture whitish, light along external emboliar margin, hemelytral bases, and centrum just posterior to tip of scutellum; embolium long, narrow (length to width, 138:: 30 = 22 per cent); embolium entirely lacking a fossa or any indication of one—embolium markedly bicolored longitudinally, outer third light yellow, remainder deep brownish black. Hemelytra moderately exposing connexival lateral edges, which are banded yellow and black brown, all posterolateral angles completely spineless. Hemelytra do not quite reach, or just reach, abdominal apex.

Venter.—The prothoracic venter has been discussed above. Remainder of venter bicolored, abdomen appearing lighter than meso- and metathoracic venters because of the dense pelt of very short, golden hydrofuge hairs; thoracic venter yellow to deep red brown; emboliar venter longitudinally bicolored, pale exteriorly, blackish interiorly. Connexival segments lacking spination or any prolongation of the posterolateral angles; lateral connexival edges absolutely smooth, nonserrate; curvature discernible but weak. Female subgenital plate largely undifferentiated at apex, with two weakly rounded "shoulders" laterally, and rising to a narrow but rounded tip; male with a short, stubby, boot-shaped genital process, the toe of which almost touches the caudal edge of the process-bearing tergite.

Legs.—Prolegs: Coxa elongate, globular, yellow to brown, smooth, shining, flattened to receive heel of femur, somewhat darker distally. Trochanter well developed as a segment between coxa and femur, distally on anterior side. Femur smooth, shiny, yellow to brown, widest near proximad end, narrowing rapidly to distal end, and with characteristic short, very dense mat of hairs along front border which serves as a resting groove for tibia when closed against femur, latter characteristically swollen and compressed dorsoventrally, ratio of length to greatest width being 120:: 72 (62 per cent), measured over ventral surface. Tibia very long, slender, smooth, colored as femur, curved most strongly in distal part, where, with the single tarsal segment, it forms a continuous, curved, grasping instrument—combined tibia-tarsus, when closed, quite markedly overlapping adjacent (proximal) end of femur.

Mesolegs: Coxa long, yellow to brown, somewhat angularly globular, equipped with short, dense, golden pile, slightly curved from posterior end weakly laterad to anterior end, the outer face flat for reception of basal part of femur. Trochanter large, distinct, same color as coxa, smooth distally, pilose proximally. Femur very long, narrow, smooth, shiny, compressed dorsoventrally, some very short, sparse, golden pile on outer proximal end; ratio of length to median width of ventral surface, 113:: 18 (16 per cent); length, 3 mm. Tibia same color, smooth, shiny, narrow, very long, strongly armed with longitudinal rows of strong, reddish-brown spines, arranged in series along the four rounded "angles" formed by the slight dorsoventral compression of tibia—distal end ventrally with two prominent, transverse rows of spines set in a solid row across width of tibia, the last row at extreme tip; ratio of length to median width, 99:: 8 (9 per cent); length, 2.5 mm. Tarsus smooth, slender, shiny, approximately same color as tibia, pilose and setulose beneath, terminating in two weakly curved claws slightly darkening at tips.

Metalegs: Coxa swollen, globular, yellow to brown, well furred with short, dense, golden to brownish pile, flattened ventrolaterally for reception of basal part of femur. Trochanter well developed, same color as coxa, pilose proximally, smooth and shiny distally. Femur long, narrow, smooth, shiny, yellow to brown, dorsoventrally compressed, weakly spinulose along outer margin; ratio of length to median width, 132:: 20 (15 per cent); length 3.1 mm. Tibia long, narrow, shiny yellow to brown, thickly armed with reddish-brown spines as in mesotibiae, but spines longer, more prominent, and more evidently unequal in size, long and short spines alternating, arranged

along four "corners" formed by the slight dorsoventral flattening–distal end ventrally with two prominent transverse rows of spines set in solid rows across tibial width, the last row at extreme tibial apex—inner length cushioned by a solid, dense, mat of long, silky golden hairs; ratio of length to median width of ventral surface, 150:: 10 (7 per cent); length, 3.7 mm. Tarsus slim, smooth, long, narrow, same color as tibia, spinulose, and pilose beneath, with weakly curved claws darkening at tips.

Type locality.—"Mexico."

Location of type.—Royal Stockholm Museum, Sweden.

Recorded distribution.—Southern Mexico to southwestern United States.

Material examined (see fig. 2).—GUATEMALA: Panzos, (iv)20, Jordan (USNM). MEXICO. CHIAPAS: Mt. Obando Queit (pool of small, swift, stream; elev. 3,000 ft.), 15(iv)40, H. M. Smith (UK); GUERRERO: S of Chilpancingo (between Cajones and Rincon), 1(vii)32, H. M. Smith

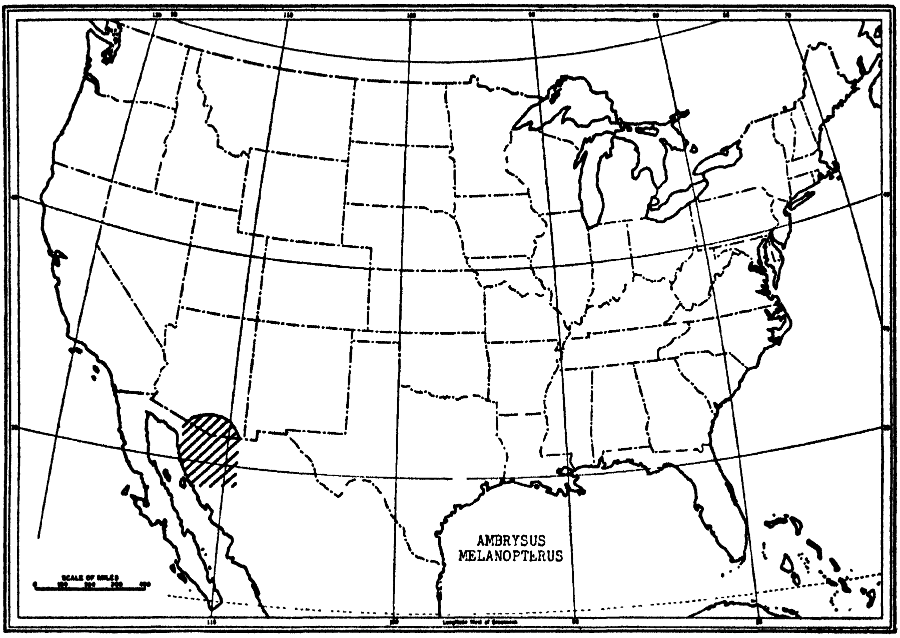

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Fig. 2. Distribution of *Ambrysus melanopterus*.

(UK); MEXICO: Temescaltepec dist., Tejupilco, 3(vii)33, H. E. Hinton–R. L. Usinger (RLU); TRES MARIAS ISLANDS: Maria Madre Island (Arroyo Hondo), 17(v)25, G. D. Hanna (RLU). UNITED STATES. ARIZONA: Santa Cruz Co., Patagonia, 7(ix)38, C. L. Hubbs and family (UM).

This species has been recorded in the literature from Texas and Arizona; whether or not some of these records are misidentifications is still a moot question. In the large amount of material assembled for this report, I at first found no specimens referable to *A. melanopterus* from the United States; in fact, judging from the total number of specimens available from the largest collections, it would seem as if the species is not particularly common anywhere. Toward the end of the study, a lone specimen was found in the University of Michigan material; this is the only specimen I have so far seen from the United States. In 1919, Hungerford translated and reprinted Stål's original description, but little else has been published on the species in this country.

Ambrysus puncticollis Stål

(Pl. 1, *c*; fig. 13, *c*)

Ambrysus puncticollis Stål, 1876, Enum. Hemip., 5: 143.
Ambrysus puncticollis, Montandon, 1897, Verh. zool.-bot. Ges. Wien, 48: 13, 20; 1909, Bull. Soc. Sci. Bucarest, 17: 322.
Ambrysus puncticollis, Van Duzee, 1917, Univ. Calif. Publ. Entom., 2: 459.
Ambrysus puncticollis, Hungerford, 1919, Bull. Univ. Kans., Sci. Bull., 11: 203.
Ambrysus puncticollis, La Rivers, 1949, Bull. So. Calif. Acad. Sci., 47(3): 108.

General appearance.—Large for the genus, comparatively long and robust, 13–15.5 mm. long, 7–9 mm. wide. Dorsum weakly bicolored, lighter and glistening anteriorly, darker and shagreened posteriorly. Venter yellowish to golden, lighter posteriorly, very slightly darker anteriorly.

Head.—Smooth, polished, impunctate, ground color yellow brown, two longitudinal median rows of brown dots occupying centrum, increasing in size posteriorly; two blotches composed of brown dots at posterior head border; when oriented so that dorsal plane is perpendicular to line of vision (i.e., the greatest amount of dorsum exposed to view), base of labrum easily visible, and particularly the two protuberant pieces bordering base of labrum, the whole entirely disrupting the smooth, anterior head outline. Eyes blackish with greenish cast; outer and inner margins slightly curved outwardly, posterior margin strongly curved; viewed from behind, eyes slightly but definitely protuberant above head surface. Head prominently sunken into anterior pronotal border. Labrum anteriorly same color as front of head, base darker; ratio of length to width, 18: : 36 (50 per cent); mouthparts same color as labrum, darkening at tip. Head ratios are:

1) Total length to width (including eyes), 42: : 66 (64 per cent).

2) Anterior distance between eyes to posterior distance, 29: : 42 (69 per cent).

3) Posterior distance between eyes to greatest length of head posterior to this line, 42: : 16 (38 per cent).

Pronotum.—Glistening, polished, rather densely set with small, shallow impressions; ground color yellow brown, disc densely set with small, brown dots except a V-shaped area in center bearing two oblong, suffused brown areas anteriorly and two brown dots posteriorly; thin, transverse, posterior pronotal line merely the line along which brown dotting of disc stops, not a distinct entity; posterior wide pronotal border whitish, closely set with tiny black points, each of which has a generally discernible white "halo"; pronotal lateral edges smooth, unserrate, usually with a very few, moderately long hairs, which may be entirely lacking; when head is firmly set into anterior pronotal margin, outer edge of pronotum and eye does not form a smooth contour but forms an emargination at the point of juncture; percentage of lateral pronotal curvature, expressed in terms of straight-line distance between anterior and posterior lateral angles and greatest vertical distance between this base line and line of curvature, is 13 per cent (75: : 10); posterior lateral angles well rounded, distinctly posterior to thin, pronotal posterior transverse line. Venter entirely golden yellow with thin, whitish margin along lateral edge; well haired along posterior margin, as well as around leg bases. Dorsal pronotal ratios are:

1) Width between anterior angles to greatest pronotal width, 68: : 138 (49 per cent).

2) Median length to greatest width, 54: : 138 (39 per cent).

3) Width between anterior angles to distance between anterior angle and posterior base line of pronotum, 68: : 75 (91 per cent).

Scutellum.—Deep reddish brown, more of a reddish cast than hemelytra, with some lightening in color at the three angles. Surface shiny but not polished, shagreened with dense, shallow, and rough punctation, each puncture the seat of a white spot; in normal position, i.e., approximately on a plane surface with remainder of body, ratio of three sides, anterior and two laterals, is 90: : 62: : 62.

Hemelytra.—Generally dark brown with a reddish tinge, no differentiation of membrane, some lightening along emboliar margin; surface shiny but not polished, shagreened as is scutellum. Embolium long and narrow for the genus (length to width, 82: : 23 = 28 per cent); narrowly yellowish along external border, as is the low, rounded, longitudinal ridge situated in anterior third of embolium adjacent to inner margin; no marginal pilosity is detectable in any of my specimens. Hemelytra rather strongly exposing lateral connexival edges, which are yellow brown,

often with some darkening at connexival junctures; extreme edges dark brown in contrast to the yellow-brown body of the connexiva, bearing some pilosity of yellow hairs which are concentrated at the segmental junctures; posterolateral angles strongly spinose. Hemelytra just reach or do not quite reach abdominal tip.

Venter.—The prothoracic venter has been discussed above. Abdominal venter densely furred with short, yellow hydrofuge pile. Mesosternum and metasternum slightly darker than abdomen because of lack of light pile, but deep golden in color throughout, with some sparse, long, lighter pilosity. Embolia venter longitudinally bicolored, lighter exteriorly, brownish internally. Connexival posterolateral spines large and prominent on all segments except segment I, which is spineless; edges of segments smooth, nonserrate, darker, weakly curved, bending quite abruptly inward under shadow of spine of adjacent segment. Female subgenital plate weakly and smoothly concave at apex, terminal lateral angles blunt, nonproduced. Male genital process short, platelike with a tendency to show a boot shape, with a slight leftward lean.

Legs.—Prolegs: Coxa elongate, somewhat angularly globular, yellow, smooth, flattened to receive heel of femur, distal edges slightly darker. Trochanter well developed as a segment between coxa and femur, smooth, shiny, amber, with a tuft of yellow hair distally on anterior end. Femur smooth, shiny, rich golden yellow, polished, widest near proximal end, narrowing rapidly to distal end, and with characteristic short, very dense mat of hairs along front border which serves as a resting groove for tibia when closed against femur, latter characteristically swollen (incrassate) and compressed dorsoventrally; ratio of length to greatest width of ventral surface is 69: : 51 (74 per cent). Tibia very long, slender, smooth, deep amber occasionally with a slight greenish tinge, darkening apically, curved most strongly in distal part where, with the single tarsal segment, it forms a continuous, curved, grasping instrument—combined tibia-tarsus, when closed, slightly but definitely exceeding adjacent (proximal) end of femur, tarsus darkening at tip.

Mesolegs: Coxa long, yellow, somewhat angularly globular, equipped with short, dense, yellow pile, slightly curved from posterior end weakly laterad to anterior end, the outer face flat for reception of basal part of femur. Trochanter large, distinct, yellow, smooth distally, pilose proximally. Femur long, narrow, smooth, shiny, amber to whitish yellow (depending upon the idiosyncrasies of drying), compressed dorsoventrally, weak and sparse setulosity on proximal third of outer or anterior and inner or posterior edges; two rows of short, dense pile on posterior (inner) face, representing, respectively, the posteroventral and posterodorsal corners; ratio of length to median width of ventral surface, 70: : 12 (17 per cent); length, 3 mm. Tibia smooth, amber, occasionally with a slight greenish tinge, shiny, long, narrow, bristling with reddish spines arranged generally in four longitudinal rows representing the four very weak "corners" of the tibia; ventrointernal (ventroposterior) row of spines consisting of single spines intermingled with very short, transverse rows of shorter spines; dorsal face proximally armed with a mat of long hairs; distal end ventrally with two prominent, complete, transverse rows of spines set solidly across the tibial apex; ratio of length to median width of ventral surface is 116: : 11 (9 per cent); length, 3 mm. Tarsus smooth, long, narrow, yellow, often with a greenish tinge; ventrally setulose and pilose, terminating in two slender, rather strongly curved, yellow claws, darkening at tips.

Metalegs: Coxa swollen, globular, yellow, well furred with short, dense, yellow pile, flattened ventrolaterally for reception of basal part of femur. Trochanter well developed, same color as coxa, pilose proximally, smooth and shiny distally. Femur long, narrow, smooth, shiny, amber, dorsoventrally compressed, sparse, short spination on outer (anterior) margin; inner (posterior) margin with two rows of reddish, chitinous points, each row representing, respectively, the posteroventral and posterodorsal corners; marked long, yellow pilosity on dorsal surface; ratio of length to median width is 81: : 14 (17 per cent), comparatively stout for the genus; length, 3.5 mm. Tibia long, narrow, shining, amber often with a greenish tinge, armed with four rows of reddish spines, the rows more or less equally spaced about the tibial circumference; a mat of dense, long, whitish-yellow hairs occupying inner (posterior) face—distal end ventrally with two prominent, complete, transverse rows of spines set solidly across tip; ratio of length to median width of ventral surface is 114: : 8 (7 per cent); length, 5 mm. Tarsus long, slender, amber (often with a greenish tint), slightly darkening at tip; spinose and pilose ventrally, terminating in two yellowish to greenish claws, dark brown at tips and rather strongly curved.

Type locality.—"Texas."

Location of type.—Royal Stockholm Museum, Sweden.

Recorded distribution.—Southwestern United States.

Material examined (see fig. 3).—MEXICO. SONORA: Buropaco dist., Alamos, 23(x)34, H. S. Gentry (RLU); San Antonio Colonial, 15(vii)27, P. A. Readio (UK). UNITED STATES. ARIZONA: Coconino Co., Bill Williams Fork, August, F. H. Snow (UK); Gila Co., Tonto Creek, 15(ix)26, Hubbs-Schultz (UM); Maricopa Co., 7(viii)27, P. A. Readio (UK); Yavapai Co., Camp Verde, 2(ix)38, C. L. Hubbs and family (UM). TEXAS: Bexar Co., Helotes, 1(vii)17, P. A. Munz (UK).

I have seen specimens of *A. puncticollis* in collections labeled "*A. melanopterus*," and I feel reasonably assured that some of these misidentifications have found their way into print in the past. This is our largest species; for that reason, if for

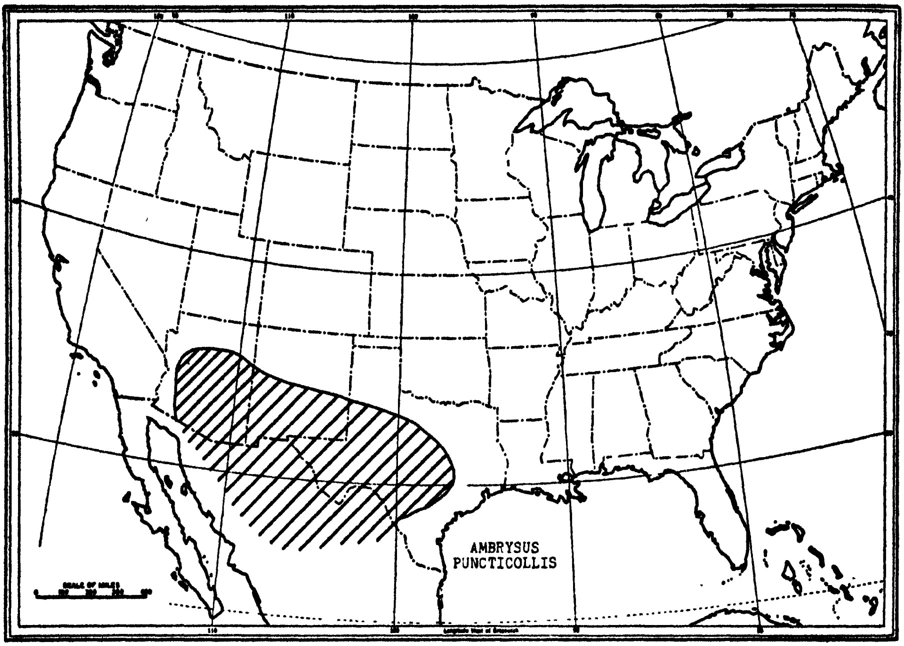

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Fig. 3. Distribution of *Ambrysus puncticollis.*

no other, it is hardly mistakable. There may be some geographical segregation, east and west, but much more field work is necessary in order to check this. Hungerford (1919) translated and reprinted Stål's original description, which constitutes about the only literature for the species in this country.

Ambrysus funebris La Rivers

(Pl. 1, *d*; fig. 13, *d*)

Ambrysus funebris La Rivers, 1949, Bull. So. Calif. Acad. Sci., 47 (3): 103.

General appearance.—The smallest, most compact species known to me—6.0–6.5 mm. long and 3.5 mm. wide. Dorsum conspicuously lighter anteriorly than it is posteriorly, unmottled, shiny. Venter deep yellowish with conspicuous darkening centrally.

Head.—Smooth, shiny, minutely punctulate; color light yellowish in anterior two-thirds, brownish in posterior part behind eyes; two unequally spaced dark, blackish sinuosities occupy centrum, between them the very faint line of light brownish dots, increasing in size posteriorly, that is

characteristically an Ambrysus pattern, is barely discernible, fusing with the brownish posterior portion of head (latter represents the "bilobed" basal spot of other species); some darkening at anterior margin of head also. When oriented so that dorsal plane is perpendicular to line of vision (i.e., the greatest amount of dorsum exposed to view), front of head is seen to be slightly protuberant before eyes, and distinctly truncate. Eyes coal black, outer margin slightly curved, inner margin straight, posterior margin strongly curved; viewed posteriorly, eyes very distinctly, but not exceptionally, strongly protuberant above general head surface, the point of juncture forming a prominent sinuosity. Head broadly and very deeply set into anterior pronotal border. Labrum same color as front of head; ratio of length to width, 15: : 29 (50 per cent); mouthparts darkening at tip. Head ratios are:

1) Total length to width (including eyes), 75: : 107 (70 per cent).

2) Anterior distance between eyes to posterior distance, 51: : 72 (71 per cent).

3) Posterior distance between eyes to greatest length of head posterior to this line, 72: : 28 (39 per cent).

Pronotum.—Shiny, smooth, minutely punctulate with incipient transverse rugulosities developing centrally behind region of deepest head penetration. Color whitish yellow laterally and posteriorly, brownish on disc with some brownish dotting laterally; central V-shaped area still detectable, with remnants of the two large, oblong brownish spots characteristic of the Ambrysus pattern; thin, blackish, posterior, transverse pronotal line very distinct, separating the darker disc from the whitish, broad posterior pronotal border; two blackish, semilunate spots present in anterolateral area of pronotal disc. Lateral pronotal margins smooth, unserrate, but rather conspicuously, although sparsely, pilose. Percentage of lateral curvature, expressed in terms of straight-line distance between anterior and posterior lateral angles and greatest vertical distance between this base line and line of curvature, is 16 per cent (102: : 16). Posterolateral angles well rounded. Venter generally yellowish brown, lightening laterally, with some darkening medially and along posterior border; conspicuous pilosity along posterior margin and on keel. Dorsal pronotal ratios are:

1) Width between anterior angles to greatest pronotal width, 70: : 118 (59 per cent).

2) Median length to greatest width, 44: : 118 (37 per cent).

3) Width between anterior angles to distance between anterior angle and posterior base line of pronotum, 70: : 67 (96 per cent).

Scutellum.—Dark brownish black with some lightening laterally. Shiny but not polished, shagreened with dense, shallow punctation, each puncture the seat of a white spot. In normal position, i.e., approximately on a plane surface with remainder of body, ratio of three sides, anterior and two laterals, is 114: : 80: : 79.

Hemelytra.—Brownish black with some vague, diffuse lightening to brownish at posterior end of clavus and behind embolium; latter bears the only light-yellow spotting of the entire pattern. Surface shiny but not polished, shagreened as is scutellum. Embolium approximately of average proportions for the genus (length to width, 102: : 32 = 32 per cent; the proportions of embolium are difficult to judge, since the posterior bordering line, usually well developed, is absent and the caudal limits must be approximated by the position of the wing sinuosity which usually marks the lateral terminus of the line), sparse but conspicuous marginal pilosity present; anterior three-fourths light yellow, posterior one-fourth and inner emboliar edge for most of its distance brownish. Hemelytra rather weakly exposing lateral connexival margins, which are light yellow with some darkening at connexival junctures; marginal pilosity conspicuous. Posterolateral connexival angles nonspinose, but slightly angulate-produced in posterior segments. Hemelytra do not quite reach abdominal tip.

Venter.—The prothoracic venter has been discussed above. Remainder of venter yellow brown, abdomen covered with dense, short, golden hydrofuge pelt, largely lacking over mesosternum and metasternum; mesosternum blackish along anterior border and centrally. Emboliar venter distinctly bicolored longitudinally, whitish exteriorly, yellowish interiorly. Connexival posterolateral angles completely nonspinose and developing in size and angulosity from anterior to posterior; angles of segment I quite completely smoothed into the general body marginal contour; angles of segment II minutely and shortly, bluntly angulate-produced, hardly breaking out of the general smoothness of the lateral contours; angles of segment III distinctly and more strongly but still

bluntly angulate-produced, while angles of IV are the ultimate in size and angulosity but still not very much larger than those of III. Connexival margins smooth, unserrate; borders about medium in width, subparallel throughout most of their lengths. Male genital process entirely lacking. Female subgenital plate simply, broadly, and shallowly concave.

Legs.—Prolegs: Coxa elongate, somewhat angularly globular, whitish yellow, smooth, flattened to receive heel of femur, distal edges distinctly darker. Trochanter well developed, smooth, shiny, same color as coxa, with a tuft of hairs distally on anterior end. Femur smooth, whitish yellow, polished, widest near proximal end, narrowing rapidly to distal end (i.e., with the characteristic swollen, incrassate appearance), compressed dorsoventrally, with typical short, dense mat of hair along front border which serves as a resting groove for tibia when closed against femur; ratio of length to greatest width of ventral surface is 97:: 59 (61 per cent). Tibia long, slender, smooth,

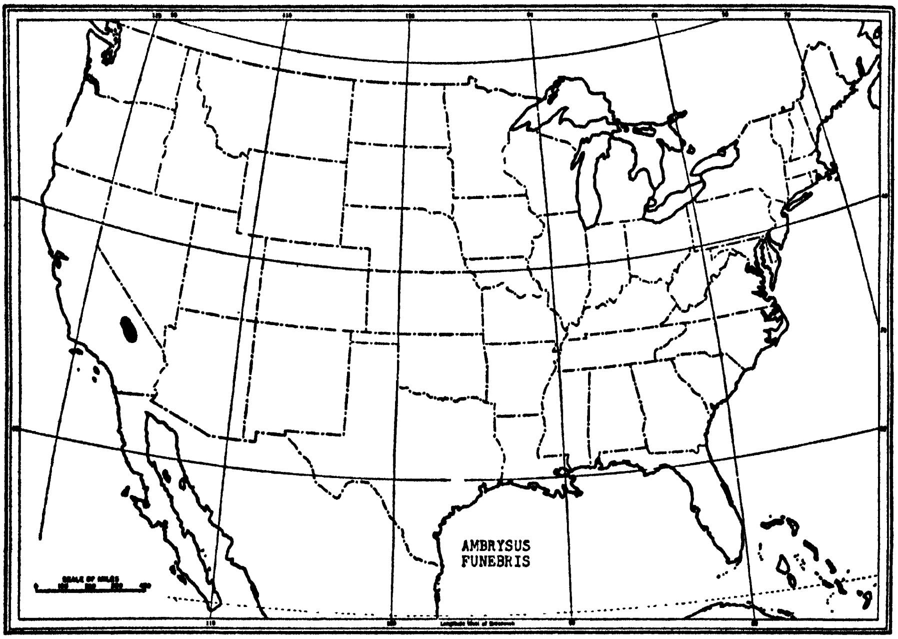

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Fig. 4. Distribution of *Ambrysus funebris.*

deep amber, darkening apically, curved most strongly in distal part where, with the single tarsal segment, it forms a continuous, curved, grasping instrument—combined tibia-tarsus, when closed, distinctly and strongly exceeding adjacent (proximal) end of femur. Tarsus darkening at tip.

Mesolegs: Coxa long, somewhat angularly globular, yellowish, equipped with short, dense pile, slightly curved from posterior end weakly to anterior end, the outer face flat for reception of basal part of femur. Trochanter large, distinct, same color as coxa, smooth distally, pilose proximally. Femur long, narrow, whitish yellow, compressed dorsoventrally, weak and sparse setulosity on outer or anterior edge; a row of short, reddish, chitinous points on dorsointernal (dorsoposterior) margin; ratio of length to median width of ventral surface is 90:: 17 (19 per cent); length, 1.40 mm. Tibia same color as femur, smooth, shiny, long, narrow, bristling with yellowish and reddish spines arranged in four longitudinal rows representing the four very weak "corners" of tibia; ventrointernal (ventroposterior) row of spines consisting of strong reddish spines alternating with weak yellow spines (instead of the usual condition for the genus in which single spines alternate with short rows of transverse spines along this border); distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row essentially complete to outer or anterior edge; ratio of length to median width of ventral surface is 76:: 8 (11 per cent); length, 1.25 mm. Tarsus smooth, long, narrow, whitish

yellow at base, blackening toward tip, pilose and setulose ventrally; terminating in two slender, amber claws, darkening at tips and rather strongly curved.

Metalegs: Coxa swollen, globular, whitish yellow, well furred with short, dense pile, flattened ventrolaterally for reception of basal part of femur. Trochanter well developed, same color as coxa, pilose proximally, smooth and shiny distally. Femur long, narrow, smooth, whitish yellow, dorsoventrally compressed; prominent, short, reddish spination on outer (anterior) margin; inner (posterior) margin with a row of reddish chitinous points dorsally and ventrally, the latter accompanied and rather obscured by a row of dense, short pile; ratio of length to median width is 108: : 19 (18 per cent); length, 1.75 mm. Tibia long, narrow, shiny, same color as femur, armed with four rows of reddish spines, the rows more or less equally spaced about tibial circumference; a mat of dense, long hairs occupying inner (posterior) face—distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row essentially complete to outer or anterior edge; ratio of length to median width of ventral surface is 123: : 13 (11 per cent); length, 2.0 mm. Tarsus smooth, long, whitish at base, blackening toward tip; spinose and pilose ventrally, terminating in two slender, amber claws, darkening at tips and rather strongly curved.

Type locality.—CALIFORNIA: Inyo Co. (Death Valley), Cow Creek, 3 mi. E of Death Valley National Monument Winter Headquarters (Funeral Range), 4(iii)48, R. Coleman; 19(vi)48, LaR and R. Coleman, elev. approx. 1,000 ft.

Location of types.—Holotype male (no. 5946), allotype (no. 5947), and four paratypes in California Academy of Sciences, San Francisco; paratypes in collections of Robert L. Usinger, Berkeley, California; Snow Museum, University of Kansas, Lawrence; U.S. National Museum, Washington, D.C.; American Museum of Natural History, New York City; British Museum (Natural History), London; Paris Museum, Paris; Death Valley National Monument, California; H. M. Parshley, Smith College, Northampton, Mass.; and the writer, Reno, Nevada.

Recorded distribution.—Only the type locality. (See fig. 4.)

See the preceding section on Biology for more information on this species.

Ambrysus pulchellus Montandon

(Pl. 2, *e*; fig. 13, *e*)

Ambrysus pulchellus Montandon, 1897, Verh. zool.-bot. Ges. Wien, 47: 11, 16; 1909, Bull. Soc. Sci. Buc.-Roum., 17: 319; 1910, Bull. Soc. Sci. Buc.-Roum., 18: 189.
Ambrysus pulchellus, Champion, 1900, Biol. Centr.-Amer., Heter., 2: 356.
Ambrysus pulchellus, Van Duzee, 1917, Univ. Calif. Publ. Entom., 2: 458.
Ambrysus pulchellus, Hungerford, 1919, Bull. Univ. Kans., Sci. Bull., 11: 200.
Ambrysus pulchellus, Usinger, 1946, Bull. Univ. Kans., Sci. Bull., 31(1): 187.

General appearance.—Small for the genus, quite narrow, 7–9.5 mm. long, 4.5–5.5 mm. wide. Dorsum generally lighter anteriorly, darker posteriorly, but contrast not striking or sharp; glistening, polished anteriorly, shagreened posteriorly. Venter generally uncontrastingly colored but slightly darker anteriorly than posteriorly.

Head.—Ground color extremely variable, varying from light yellow through darker browns to a bright green; shiny, polished, impunctate (but occasionally sparsely and microscopically punctate laterally), usually with two discernible median longitudinal rows of brown dots occupying the centrum and becoming increasingly large posteriorly, and often bordered laterally by two dark sinuosities which always appear subdermal in origin (in green individuals, the entire dorsal pigmentation appears markedly subdermal); head with two irregular patches of brown posteriorly, inset with dots, each dot the site of a very shallow depression; two short, dark lines in vicinity of posterointernal eye angle; when oriented so that dorsal plane is perpendicular to line of vision (i.e., the greatest amount of dorsum exposed to view), front is seen to be advanced before the eyes, but the outline of head front and outer eye margins forms a completely smooth semicircle. Eyes dark red brown to black, pearly circles of ommatidia giving a gray aspect in certain lights; outer eye margin only very faintly curved, almost straight, inner margin distinctly but not markedly curved laterad, posterior margin moderately curved; viewed from behind, eyes absolutely flush with head surface, no perceptible protuberance; ratio of inner

length to outer length to a straight-line distance between caudal ends of inner and outer lengths is 40 : : 32 : : 31. Head only moderately sunken into anterior pronotal border. Labrum same color as front of head; ratio of length to width is 17 : : 36 (47 per cent); mouthparts generally darkening at tip. Head ratios are:

1) Total length to width (including eyes), 66 : : 100 (66 per cent).

2) Anterior distance between eyes to posterior distance, 43 : : 55 (78 per cent).

3) Anterior distance between eyes to inner eye margin, 43 : : 40 (93 per cent).

4) Posterior distance between eyes to greatest length of head posterior to this line, 55 : : 20 (36 per cent).

5) Anterior distance between eyes to greatest length of head anterior to this line, 43 : : 5 (12 per cent).

Pronotum.—Shiny, polished, impunctate, often with distinct but thin transverse lines in anterior centrum behind area of deepest head penetration, indicative of the pronounced transverse rugulosity which develops in other, more roughened species; ground color yellow through brown to green, entire centrum, including anterior border, mottled with brown spots, only a median V area immediately behind the region of deepest head penetration free from the mottling, and this suffusedly brownish with two conspicuous twin brown dots near base of V; thin, transverse, posterior pronotal line varying from a well-developed, "dashed" line, in yellow and brown specimens, to merely a subdermal impression, in green individuals, in which the line may be only a change in color from the greenish centrum to the distinctly lighter, wide, posterior border; this posterior border is distinctly lighter in color than remainder of centrum and is closely set with small, blackish points, each point with a generally discernible white "halo"; pronotal lateral edges smooth, unserrate, in unrubbed specimens with some moderately long, sparse, yellow hairs along edge, discernible only with considerable magnification; outer pronotal and eye margins more or less smoothly blending (i.e., not meeting in a definite angle); lateral pronotal curvature, expressed in terms of straight-line distance between anterior and posterior lateral angles and greatest vertical distance between this base line and line of curvature, is 13 per cent (90 : : 12); posterolateral angles weak or lacking as definite entities, always situated posterior to transverse posterior pronotal line, not evidently at widest point of pronotum. Venter generally light, darker posteriorly and about the medial keel, the posterior border and keel conspicuously armed with long, whitish hairs. Dorsal pronotal ratios are:

1) Width between anterior angles to width between posterior angles, 50 : : 84 (60 per cent).

2) Median length to greatest width, 34 : : 84 (40 per cent).

3) Distance between anterior angles and posterior angle on same side to perpendicular distance between anterior angle and base line of pronotum, 44 : : 49 (90 per cent).

The comparative increase in width of the anterior pronotal end is significant in this species.

Scutellum.—Reddish brown to blackish (even in green specimens), thinly yellow along lateral edges; surface shiny but not polished, shagreened with dense, shallow and rough punctation, each puncture the seat of a white spot; in normal position, i.e., approximately on a plane surface with remainder of body, ratio of three sides, anterior and two laterals, is 57 : : 44 : : 43.

Hemelytra.—Deep reddish brown to black, laterally with some greenish cast in green individuals, lightening along emboliar margins, and often with a small but distinct light-yellow or green spot in vicinity of membrane-corium juncture; shagreenation of dense, white-seated punctures as in scutellum; membrane not distinct from remainder in color. Embolium very long and narrow for the genus (length to width, 115 : : 31 = 27 per cent) to normal (95 : : 30 = 32 per cent), lighter in anterior two-thirds, dark in posterior third; in unrubbed specimens a few sparse yellowish hairs along the outer emboliar edge. Hemelytra rather markedly exposing lateral connexival edges, which are light yellow with some darkening at connexival junctures; posterolateral connexival angles slightly produced, but not spinous; entire connexival edges short pilose with an occasional long, prominent hair interspersed. Hemelytra reach abdominal tip.

Venter.—The prothoracic venter has been discussed above. Abdominal venter yellow, thickly furred with short, hydrofuge pile, with small, vague dark areas at lateral connexival junctures. Mesosternum and metasternum light, with some dark areas medially and anteriorly. Emboliar venter light exteriorly, dark inwardly. Connexival posterolateral angles all slightly produced except segment I, but this weak prolongation detectable only with considerable magnification;

all connexival lateral edges smooth, unserrate. Female subgenital plate unequally quadrisinuate, the two central sinuosities more prominent than the lower laterals. Male genital hook short but well developed, moderately bent to the left.

Legs.—Prolegs: Coxa elongate, somewhat angularly globular, whitish, smooth, flattened to receive heel of femur, distal edges slightly darker. Trochanter well developed as a segment between coxa and femur, smooth, shiny, whitish, with a tuft of yellow hairs distally on anterior end. Femur smooth, shiny, whitish yellow, polished, widest near proximal end, narrowing rapidly to distal end, and with characteristic short, very dense mat of hairs along front border which serves as a resting groove for tibia when closed against femur, latter characteristically swollen, compressed dorsoventrally; ratio of length to greatest width of ventral surface is 76:: 53 (70 per cent). Tibia very long, slender, smooth, shiny, amber, darkening apically, curved most strongly in distal part, where, with the single tarsal segment, it forms a continuous, curved, grasping instrument—combined tibia-tarsus, when closed, just slightly, if at all, overlapping adjacent (proximal) end of femur; tarsus darkening at tip.

Mesolegs: Coxa long, whitish yellow, somewhat angularly globular, equipped with short, dense, yellowish-white pile, slightly curved from posterior end weakly laterad to anterior end, the outer face flat for reception of basal part of femur. Trochanter large, distinct, whitish, smooth distally, pilose proximally. Femur long, narrow, smooth, shiny, whitish, compressed dorsoventrally, weak and sparse setulosity on both anterior and posterior lengths, a sparse row of longer spines on anterior (outer) face interspersed among the setules; a row of short, dense pile on posterior (inner) face; ratio of length to median width of ventral surface is 78:: 16 (21 per cent); length, 2.0 mm. Tibia whitish, smooth, shiny, long, narrow, bristling with series of unequal reddish spines standing out at prominent angles from the tibial length; spines arranged in longitudinal rows along the four "corners" of tibia; inner face with several short transverse series of short spines at irregular intervals; dorsal face matted with dense, long whitish hairs; distal end ventrally with one prominent, complete transverse row of spines solidly set across tibial apex; remnants of the usual second row proximal to the distal row are present in sufficient quantity to form a partial second row which extends approximately halfway across tibia, with other half of tibia bare and lacking even an isolated spine which could be postulated as a remnant of the same row; ratio of length to median width of ventral surface is 68:: 7 (10 per cent); length, 1.85 mm. Tarsus smooth, whitish, long, narrow, ventrally setulose and pilose, terminating in two long, slender whitish claws, ambering at tip, moderately curved.

Metalegs: Coxa swollen, globular, whitish yellow, well furred with short, dense, white pile, flattened ventrolaterally for reception of basal part of femur. Trochanter well developed, same color as coxa, pilose proximally, smooth and shiny distally. Femur long, narrow, smooth, shiny, whitish, dorsoventrally compressed, setulosity moderate along outer margin, inner margin with two rows of chitinous points feathered with short white pile; ratio of length to median width is 96:: 20 (21 per cent); length, 2.80 mm. Tibia long, narrow, shining, whitish, armed with four rows of unequal, reddish spines, the rows more or less equally spaced about the tibial circumference; a mat of dense, long, whitish hairs occupying inner face—distal end ventrally with one prominent, complete, transverse row of spines set solidly across tip, remnants of the usual second row proximal to the distal row are present as a partial row which extends about halfway across tibia; ratio of length to median width of ventral surface is 119:: 9 (8 per cent); length, 2.90 mm. Tarsus long, slender, whitish, only slightly darkening at tip, spinose and pilose ventrally, terminating in two whitish, amber-tipped, moderately curved spines.

Type locality.—"Guatemala."

Location of type.—Museum of Hamburg, Germany.

Recorded distribution.—Texas to Guatemala.

Material examined (see fig. 5).—GUATEMALA: Los Amates, Kellerman (MCZ). MEXICO. CHIAPAS: La Libertad, 1(i)38, O. U. Louis (500 m. above sea level) (UK); MICHOACAN: Uruapan dist., El Sabino, 28(vii)36, H. D. Thomas (UK); MORELOS: Rio Amacuza, 133 kilom. S of Mexico City, 14(x)36, H. D. Thomas (UK); TAMAULIPAS: 3½ mi. W of Forlon, 8(viii)34, Smith and Dunkle (UK); 5 mi. S of Victoria (xi)36, H. D. Thomas (UK). UNITED STATES. ARIZONA: Cochise Co., 29(vii)27, R. H. Beamer (UK). TEXAS: Kerr Co., 8(iv)39, D. Millspaugh (RLU); Sutton Co., Roosevelt, 21(iv)24, J. O. Martin (RLU); Uvalde Co., Concan, 6(vii)36, M. B. Jackson (UK); Val Verde Co., Del Rio, 8(vii)38, R. I. Sailer (UK).

Ambrysus pulchellus pallidulus Montandon, 1910, described as from "Texas Belfrage. U.S.N.M. Washington et ma collection," is, to my mind, a synonym of *A. pulchellus,* falling well within the range of observed variation of the latter. Hungerford (1919) translated and reprinted Montandon's original descriptions of *A. pulchellus* and *A. p. pallidulus,* and Usinger (1946) briefly discussed the species, chiefly from a large series taken in Temescaltepec (Tejupilco), Mexico, in 1933.

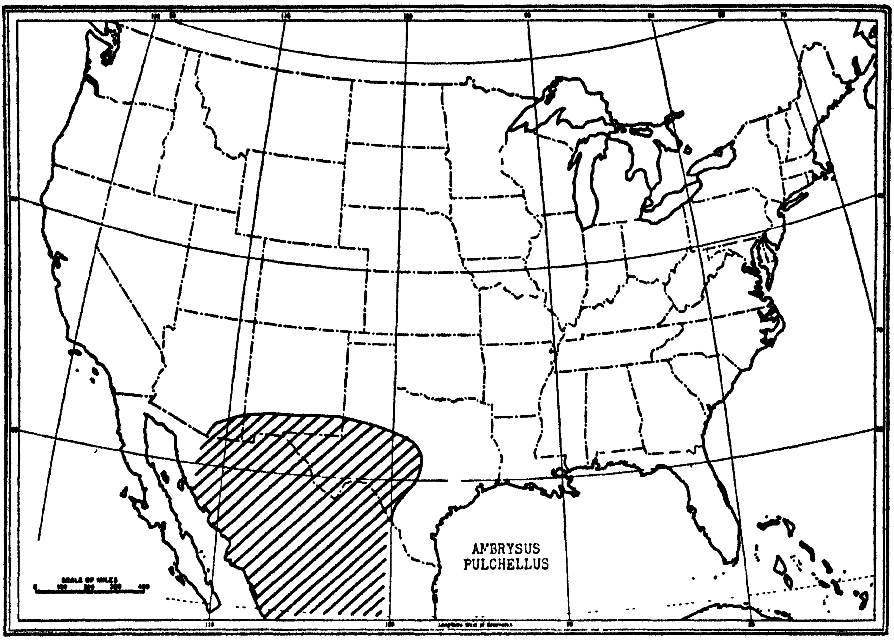

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Fig. 5. Distribution of *Ambrysus pulchellus.*

Ambrysus californicus Montandon

Pl. 2, *f* and *f'*; fig. 13, *f*)

Ambrysus californicus Montandon, 1897, Verh. zool.-bot. Ges. Wien, 47: 12, 18; 1909, Bull. Soc. Sci. Buc.-Roum., 17 (5–6): 320.
Ambrysus californicus, Van Duzee, 1917, Univ. Calif. Publ. Entom., 2: 458.
Ambrysus californicus, Hungerford, 1919, Bull. Univ. Kans., Sci. Bull., 11: 204.
Ambrysus californicus, Usinger, 1946, Bull. Univ. Kans., Sci. Bull. 31, (1): 196.
Ambrysus californicus, Usinger-La Rivers-Chandler-Wirth, 1948, Univ. Calif. Syll. Ser. SS: 178.
Ambrysus californicus, La Rivers, 1949, Bull. So. Calif. Acad. Sci., 47 (3): 108.

KEY TO SUBSPECIES

Posterolateral connexival angles nonproduced, spineless. . . . . *californicus californicus*
Posterolateral connexival angles produced, spined. . . . . *californicus bohartorum*

Ambrysus californicus californicus Montandon

(Pl. 2, *f*)

General appearance.—Small, unmottled, compact species, 7.5–8.5 mm. long, 4.75–6.0 mm. wide. Dorsum yellow brownish to greenish, lighter anteriorly, darker posteriorly. Venter quite vari-

colored, body brownish red to blackish with greenish casts, and (in the specimens at my disposal) the legs are almost invariably predominantly greenish.

Head.—Ground color light yellow to yellow brown, with or without greenish suffusions; two generally prominent, short, longitudinal streaks medially, each streak obviously composed of coalesced dots, increasing in size posteriorly, and varying in color from brown to green, usually the former; often two greenish, longitudinal areas on each side of the median streaks, varying from vague suffusions to definite, thin sinuosities; a bilobed spot at base of head of suffused brown or green, with a few dots, either free or coalesced with the median streaks. Surface glistening in clean specimens, microscopically but insignificantly punctulate and slightly roughened. When oriented so that dorsal plane is perpendicular to line of vision (i.e., the greatest amount of dorsum exposed to view), front of head is seen to be slightly protuberant before the eyes, and with a suggestion of truncation. Eyes generally blackish, with some gray lights; outer margin scarcely curved, inner margin more noticeably curved, and posterior margin strongly curved; viewed posteriorly, eyes slightly but distinctly protuberant above general head surface, the point of juncture producing a weak sinuosity. Head moderately deeply set into anterior pronotal border. Labrum same color as front of head, in greenish specimens even more pronouncedly green than head front; ratio of length to width is 15: : 31 (48 per cent); mouthparts darkening to deep amber, even in greenish specimens. Head ratios are:

1) Total length to width (including eyes), 61: : 96 (64 per cent).

2) Anterior distance between eyes to posterior, 45: : 60 (75 per cent).

3) Posterior distance between eyes to greatest length of head posterior to this line, 60: : 16 (27 per cent).

Pronotum.—Shiny but not polished, minutely punctulate, in some specimens with a slight suggestion of transverse rugulosity in anterior centrum behind area of deepest head penetration. Ground color yellow brown to brown, with or without varying amounts of greenish suffusion and, on the disc, a variable development of mottling and dotting that never crystallizes into a definite pattern. Thin, transverse, posterior pronotal line generally distinct, separating the varicolored disc from the broad, whitish to greenish, posterior pronotal border, which is usually set with microscopic, blackish points. Lateral edges smooth, unserrate, with readily detectable but not dense marginal pilosity in unrubbed specimens; when head is firmly set in anterior pronotal border, outer edge of pronotum and eye forms a contour which varies from being markedly interrupted at point of juncture to being almost smooth, some individuals with a considerable comparative lateral expansion of chitinous bar bordering eye posteriorly. Percentage of pronotal curvature, expressed in terms of straight-line distance between anterior and posterior lateral angles and greatest vertical distance between this base line and line of curvature, is 14 per cent (92: : 13). Posterolateral angles well rounded. Venter yellowish brown, often with considerable greenish tinge, particularly at margins; conspicuous long pilosity on posterior border and keel. Dorsal pronotal ratios are:

1) Width between anterior angles to width between posterior angles, 49: : 91 (54 per cent).

2) Median length to greatest width, 30: : 91 (33 per cent).

3) Width between anterior angles to distance between anterior angle and posterior base line of pronotum, 49: : 48 (98 per cent).

Scutellum.—Yellowish to reddish brown, often with considerable greenish tinge, usually with some yellowish lightening at the three angles, particularly the laterals; shiny but not polished, shagreened with dense, shallow punctation, each puncture the seat of a white spot. In normal position, that is, approximately on a plane surface with remainder of body, ratio of three sides, anterior and two laterals, is 64: : 45: : 44.

Hemelytra.—Pale yellowish green to blackish brown, generally contrasting in color with the scutellum but without any conspicuous mottling, the lightening in color occurring only on embolia and (vaguely) on clavus. Surface shiny but not polished, shagreened as in scutellum. Embolium of normal length and width (length to width, 56: : 18 = 32 per cent), sparse pilosity marginally, generally lighter exteriorly and anteriorly, often only very vaguely so, and in some greenish specimens, entirely light with no darkening posteriorly. Hemelytra markedly exposing lateral connexival margins, which are yellowish to greenish with some darkening at connexival junctures, and with some short, dense, marginal pilosity; posterolateral connexival angles distinctly angulate-produced, but not truly spinose. Hemelytra variable in length, attaining abdominal tip, or exposing a considerable portion of tip.

Venter.—The prothoracic venter has been discussed above. Remainder of venter distinctly bicolored, the abdomen much lighter by virtue of the dense pelt of short, golden hydrofuge hairs covering the basic, deep amber color; mesosternum and metasternum brownish, occasionally with greenish tinges; no significant longitudinal bicoloration to emboliar venter, except in green individuals—in these the margin is greenish, the remainder brownish. Connexival posterolateral angles somewhat variable in their development; angle of segment I may be obscure, rounded or sharply right-angulate, II either sharply right-angulate or slightly spinosely produced, III sharply less than right-angulate to distinctly spinosely produced, IV large and seemingly invariably sharply less than right-angulate but not showing any noticeable spinosity; connexival margins quite smooth, only some insignificant microscopic irregularities occasionally on posterior segments, border more or less parallel or subparallel its entire length, not, as in the common opposite condition, decreasing progressively in width from posterior to anterior end; posterolateral angles usually distinctly darker in color than remainder of border. Female subgenital plate terminally more or less evenly quadriangulate, the central "angles" low, broad, well rounded, the lateral shoulder "angles" generally fairly sharp. Male genital hook long, narrow, well developed with a prominent curve or lean to the left.

Legs.—Prolegs: Coxa elongate, somewhat angularly globular, light yellow to greenish, smooth, flattened to receive heel of femur, distal edges darker. Trochanter well developed, smooth, shiny, same color as coxa, with a tuft of yellowish hairs distally on anterior end. Femur smooth, shiny, whitish yellow to green, polished, widest near proximal end, narrowing rapidly to distal end (i.e., with the characteristic swollen, incrassate appearance), compressed dorsoventrally, with typical short, very dense mat of hairs along front border which serves as a resting groove for tibia when closed against femur; ratio of length to greatest width of ventral surface is 69: : 44 (64 per cent). Tibia very long, slender, smooth, yellowish to greenish, darkening apically, curved most strongly in distal part, where, with the single tarsal segment, it forms a continuous, curved, grasping instrument—combined tibia-tarsus, when closed, attaining, or slightly exceeding, adjacent (proximal) end of femur. Tarsus darkening at tip.

Mesolegs: Coxa long, light yellow or greenish yellow to amber, somewhat angularly globular, equipped with short, dense, yellow pile, slightly curved from posterior end weakly to anterior end, the outer face flat for reception of basal part of femur. Trochanter large, distinct, light yellow to greenish, smooth distally, pilose proximally. Femur long, narrow, smooth, shiny, whitish yellow to green, compressed dorsoventrally, weak and sparse setulosity on proximal third or less of outer or anterior edge; a row of short, reddish, chitinous points on dorsointernal (dorsoposterior) margin and short, dense, anteriorly weak pilosity on ventrointernal (ventroposterior) margin; ratio of length to median width of ventral surface is 70: : 13 (19 per cent); length, 1.85 mm. Tibia light yellow to green, smooth, shiny, long, narrow, bristling with reddish spines arranged in four longitudinal rows representing the four very weak "corners" of tibia; ventrointernal (ventroposterior) row of spines consisting of single spines intermingled with very short, transverse rows of shorter spines; dorsal face proximally clothed with a mat of long, yellow hairs; distal end ventrally with two transverse rows of spines, the terminal row prominent, set solidly across tibial apex (occasionally some spines may be missing from this row, apparently because of breakage during life), the secondary or proximal row very incomplete, only half length of terminal row (i.e., extending half or less the tibial width); ratio of length to median width of ventral surface is 62: : 8 (13 per cent); length, 1.50 mm. Tarsus smooth, long, narrow, same color as tibia, pilose and setose beneath; terminating in two slender, amber to greenish claws, darkening at tips and not strongly curved.

Metalegs: Coxa swollen, globular, yellow to greenish, well furred with short, dense, yellow pile, flattened ventrolaterally for reception of basal part of femur. Trochanter well developed, whitish yellow to green, pilose proximally, smooth and shiny distally. Femur long, narrow, smooth, whitish yellow to green, dorsoventrally compressed; sparse, short, reddish spination on outer (anterior) margin; inner (posterior) margin with a row of reddish chitinous points dorsally, and short, dense, pilosity ventrally; markedly long pilosity on posterodorsal edge; ratio of length to median width is 56: : 10 (18 per cent); length, 2.75 mm. Tibia long, narrow, shiny, whitish yellow to green, armed with four rows of reddish spines, the rows more or less equally spaced about the tibial circumference; a mat of dense, long, yellow to amber hairs occupying inner (posterior) face—distal end ventrally with two transverse rows of spines, the terminal row prominent, set

solidly across tibial apex, the secondary or proximal row very incomplete, only half the length of terminal row, or less (i.e., extending half or less of the tibial width); ratio of length to median width of ventral surface is 65: : 6 (9 per cent); length, 3 mm. Tarsus smooth, long, slender, same color as tibia; spinose and pilose ventrally, terminating in two amber (often green-tinged) claws, darkening at tips, and rather strongly curved.

Type locality.—"Southern California."

Location of type.—Royal Stockholm Museum, Sweden.

Recorded distribution.—California.

Material examined (see fig. 6).—CALIFORNIA: Alameda Co., Livermore, 14(ix)30, R. L. Usinger; Niles Canyon, 15(iv)22, E. C. Van Dyke (RLU); Contra Costa Co., Walnut Creek, 26(ix)19, E. C. Van Dyke (RLU); Lake Co., Lower Lake, 14(v)22, G. D. Hanna (RLU); Mendocino Co., Cache

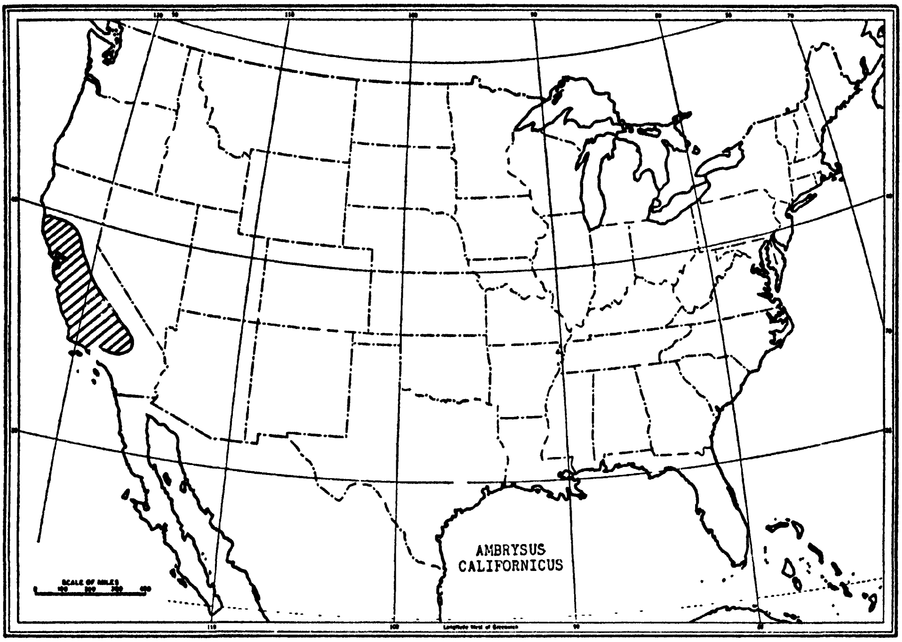

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Fig. 6. Distribution of *Ambrysus californicus.*

Creek near Ramsey, 29(iii)42, R. L. Usinger (RLU); Monterey Co., Bradley, 8(iii)37, E. S. Ross, H. B. Leech, M. Cazier; Carmel, 6(i)16, L. S. Slevin (RLU); Mojave Desert, Deep Creek, 5(v)36, E. G. Linsley (RLU); San Luis Obispo Co., Nipomo, 24(vii)35, R. H. Beamer (UK); San Miguel, 26(ix)27, L. S. Slevin (RLU); Santa Barbara Co., Sisquoc River, 13(vi)16, C. L. Hubbs (RLU); Ventura Co., 12(viii)16, E. O. Essig (RLU).

Ambrysus californicus bohartorum Usinger

(Pl. 2, *f'*)

Ambrysus bohartorum Usinger, 1946, Bull. Univ. Kans., Sci. Bull., 31 (1): 195.
Ambrysus bohartorum, Usinger-La Rivers-Chandler-Wirth, 1948, Univ. Calif. Syll. Ser. SS: 178.
Ambrysus bohartorum, La Rivers, 1949, Bull. So. Calif. Acad. Sci., 47 (3): 108.

General appearance.—Small, unmottled, compact variety, 8.5–9 mm. long, 5–6.25 mm. wide. Dorsum yellow brownish to greenish, lighter anteriorly, darker posteriorly, shiny. Venter with no conspicuous sharp dark markings; lighter posteriorly than anteriorly, legs either same general color as venter or contrastingly green.

Head ratios are:

1) Total length to width (including eyes), 66: : 96 (69 per cent).

2) Anterior distance between eyes to posterior distance, 48: : 62 (77 per cent).

3) Posterior distance between eyes to greatest length of head posterior to this line, 62: : 18 (29 per cent).

Dorsal pronotal ratios are:

1) Width between anterior angles to width between posterior angles, 50: : 96 (52 per cent).

2) Median length to greatest width, 30: : 96 (31 per cent).

3) Width between anterior angles to distance between anterior angle and posterior base line of pronotum, 50: : 45 (90 per cent).

This is identical with *A. c. californicus* so far as falling within the limits of specific variability of *A. californicus* is concerned, and differs only in the following respects: (1) it averages slightly larger in size, and (2) it possesses spined, or produced, connexival angles in contrast to the nonproduced condition of the connexival angulation in the typical subspecies. See the section on Geography for further brief comments on these two subspecies.

Type locality.—"Austin Creek, near Cazadero, Sonoma County, California, April 30, 1935, R. M. and G. E. Bohart, collectors."

Location of type.—"Holotype, female (California Academy of Sciences)," San Francisco.

Recorded distribution.—California.

Material examined (see fig. 6).—CALIFORNIA: Alameda Co., Livermore, 14(ix)30, R. L. Usinger (RLU); Monterey Co., King City (Salinas River), 14(v)16, C. L. Hubbs (UK); San Luis Obispo Co., 1(vi)16, C. L. Hubbs (UK); Sonoma Co., Austin Creek near Cazadero, 30(iv)35, R. M. and G. E. Bohart (RLU).

Ambrysus buenoi Usinger

(Pl. 2, *g*; fig. 13, *g*)

Ambrysus buenoi Usinger, 1946, Bull. Univ. Kans., Sci. Bull. 31, (1): 199.

General appearance.—Medium-sized for the genus, 8.5–10 mm. long, 5.5–6 mm. wide. Dorsum yellowish brown, varying on the one hand toward deep reddish, on the other to greenish, suffusions; scutellum may stand out somewhat more darkly than remainder, and head–prothorax may be somewhat lighter than hemelytra in general. Venter dark reddish brown, darkening anteriorly and medially.

Head.—Amber to yellowish with greenish tints, smooth, shiny, polished, microscopically very irregularly punctulate, with some thin, transverse, very short lines discernible irregularly over the surface; when oriented so that dorsal plane is perpendicular to line of vision (i.e., the greatest amount of dorsum exposed to view) front of head is seen to be very weakly protuberant between eyes. Eyes black, outer margins straight, inner margin very weakly concave laterally, posterior margin strongly curved; ratio of inner margin to outer margin to a straight line drawn between the posterior ends of inner and outer margins is 41: : 32: : 29; viewed posteriorly, eyes weakly but distinctly protuberant above head surface, the juncture of the two forming a slight, smooth sinuosity in outline. Head rather prominently sunken into anterior pronotal border. Labrum same color as front of head; ratio of length to width, 11: : 23 (48 per cent); mouthparts darker than labrum, or same color but darkening at tip. Head ratios are:

1) Total length to width (including eyes), 66: : 103 (64 per cent).

2) Anterior distance between eyes to posterior, 45: : 65 (75 per cent).

3) Anterior distance between eyes to inner margin of eyes, 45: : 41 (91 per cent).

4) Posterior distance between eyes to greatest length of head posterior to this line, 65: : 22 (34 per cent).

Pronotum.—Glistening but not polished, densely, shallowly punctate, punctures somewhat larger behind area of deepest head penetration; color amber to light yellow, the yellow being often tinged with green; wide posterior pronotal border distinct from disc, separated by the

thin, transverse, posterior pronotal line; lateral edges smooth, unserrate, in unrubbed specimens a sparse line of yellow hairs present; when head is firmly set in anterior pronotal margin, outer edge of pronotum and eye almost forms a smooth contour, the emargination produced at the juncture quite small; lateral pronotal curvature, expressed in terms of straight-line distance between anterior and posterior lateral angles and greatest vertical distance between this base line and line of curvature, is 14 per cent (98: : 14); posterolateral angles well rounded. Venter amber to brownish, lighter laterally; well furred posteriorly and medially. Dorsal pronotal ratios are:

1) Width between anterior angles to greatest pronotal width, 54: : 102 (53 per cent).

2) Median length to greatest width, 33: : 102 (32 per cent).

3) Width between anterior angles to distance between anterior angle and posterior base line of pronotum, 54: : 51 (94 per cent).

Scutellum.—Deep reddish, either same color as hemelytra or slightly darker, but not contrastingly so, generally with some lightening in color at the posterior angle. Surface shiny but not polished, shagreened with dense, shallow, and rough punctation, each puncture the seat of a white spot; in normal position, i.e., approximately on a plane surface with remainder of body, ratio of three sides, anterior and two laterals, is 70: : 50: : 50.

Hemelytra.—Uniformly reddish brown, often with a greenish cast, and with some slight lightening in color along emboliar margin; surface shiny but not polished, shagreened as is scutellum. Embolium somewhat narrow (length to width, 61: : 8 = 30 per cent); weakly lighter in color externally, a faint marginal pilosity usually present. Hemelytra rather markedly exposing lateral connexival edges which are yellow brown, with no definite darkening at connexival lateral junctures; some pilosity marginally; posterolateral angles moderately spinose. Hemelytra not quite attaining abdominal tip.

Venter.—The prothoracic venter has been discussed above. Abdominal venter deep reddish brown, covered with a golden pelt of short, dense, hydrofuge hairs. Mesosternum and metasternum darker because of lack of hydrofuge pelt. Emboliar venter longitudinally bicolored, externally amber, internally brownish. Connexival posterolateral angles mediumly spinose except segment I, spines progressively increasing in size posteriorly; margins smooth, unserrate, moderately pilose; anterior margins dipping inward rather abruptly under shadow of spines of adjacent segment. Female subgenital plate moderately concave at apex, the two lateral terminal angles sharp. Male genital hook prominent, widely, weakly capitate, with a strong left lean.

Legs.—Prolegs: Coxa elongate, somewhat angularly globular, amber to greenish, smooth, flattened to receive heel of femur, distal edges darker. Trochanter well developed, smooth, shiny, amber to light yellow with greenish tints, with a tuft of yellow hairs distally on anterior end. Femur smooth, shiny, amber to green, polished, widest near proximal end, and narrowing rapidly to distal end (i.e., with the characteristic swollen appearance), compressed dorsoventrally, with typical short, very dense mat of hairs along front border which serves as a resting groove for tibia when closed against femur; ratio of length to greatest width of ventral surface is 84: : 54 (64 per cent). Tibia very long, slender, smooth, amber to green, darkening apically, curved most strongly in distal part where, with the single tarsal segment, it forms a continuous, curved, grasping instrument—combined tibia-tarsus, when closed, just attaining, or slightly exceeding, adjacent (proximal) end of femur; tarsus darkening at tip.

Mesolegs: Coxa long, deep amber, somewhat angularly globular, equipped with short, dense, yellow pile, slightly curved from posterior end weakly laterad to anterior end, the outer face flat for reception of basal part of femur. Trochanter large, distinct, amber, smooth distally, pilose proximally. Femur long, narrow, smooth, shiny, amber to greenish, compressed dorsoventrally, weak and sparse setulosity on proximal third of outer or anterior edge; two rows of short, dense pile on posterior (inner) face, representing, respectively, the posteroventral and posterodorsal corners; ratio of length to median width of ventral surface is 90: : 8 (20 per cent); length, 2.25 mm. Tibia amber to green, smooth, shiny, long, narrow, bristling with reddish spines arranged in four longitudinal rows representing the four very weak "corners" of the tibia; ventrointernal (ventroposterior) row of spines consisting of single spines intermingled with very short, transverse rows of shorter spines; dorsal face proximally armed with a mat of long yellow hairs; distal end ventrally with one prominent, transverse row of spines, set solidly across tibial apex; remnants of the usual second, proximal row present as a half row on inner or posterior half of

tibia; ratio of length to median width of ventral surface is 72: : 8 (11 per cent); length, 1.95 mm. Tarsus smooth, long, narrow, amber to green; spinose and pilose beneath, terminating in two slender yellowish claws, darkening at tips, rather strongly curved.

Metalegs: Coxa swollen, globular, deep brown amber, well furred with short, dense yellow pile, flattened ventrolaterally for reception of basal part of femur. Trochanter well developed, amber, pilose proximally, smooth and shiny distally. Femur long, narrow, smooth, shiny, amber, dorsoventrally compressed; sparse, short, reddish spination on outer (anterior) margin; inner (posterior) margin with two rows of reddish, chitinous points, each row representing, respectively, the posteroventral and posterodorsal corners; markedly long pilosity on posterodorsal edge; ratio of length to median width is 59: : 10 (17 per cent); length, 2.75 mm. Tibia long, narrow, shiny, amber to greenish, armed with four rows of reddish spines, the rows more or less equally spaced about the tibial circumference; a mat of dense, yellow, long hairs occupying inner (posterior)

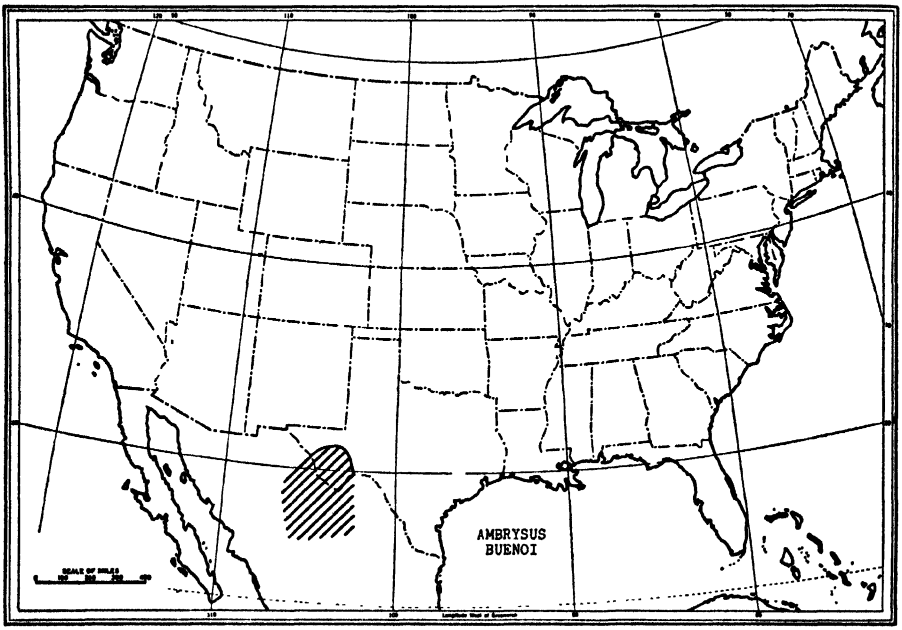

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Fig. 7. Distribution of *Ambrysus buenoi.*

face—distal end ventrally with one prominent, transverse row of spines set solidly across tibial apex; remnants of the usual second, proximal row present as a half row on inner or posterior half of tibia; ratio of length to median width of ventral surface is 130: : 9 (7 per cent); length, 3.25 mm. Tarsus smooth, long, slender amber to greenish; spinose ventrally and inwardly, terminating in two yellowish claws, darkening at tips, weakly curved.

Type locality.—"Rio Grande, Brewster Co., Texas, June 13–17, 1908, Mitchell and Cushman collectors."

Location of types.—"Holotype, male (U.S. National Museum) . . . Allotype, female, and a male and female paratype, same data as type" the last three in the Usinger collection.

Recorded distribution.—Southern Texas.

Material examined (see fig. 7).—MEXICO: San Antonio, 15(vii)28, R. H. Beamer (RLU). UNITED STATES. TEXAS: The allotype (see above).

Ambrysus mormon Montandon

(Pl. 3, *h* and *i;* fig. 13, *h* and *i*)

Ambrysus mormon Montandon, 1909, Bull. Soc. Sci. Buc.-Roum., 18 (1): 48; 1910, Bull. Soc. Sci. Buc.-Roum., 18 (5–6): 180–191.

Ambrysus mormon, Van Duzee, 1917, Univ. Calif. Publ. Entom., 2: 459.
Ambrysus mormon, Hungerford, 1919, Bull. Univ. Kans. Sci., Sci. Bull., 11: 202.
Ambrysus mormon, Usinger, 1946, Bull. Univ. Kans., Sci. Bull., 31 (1): 186.
Ambrysus mormon, Usinger-La Rivers-Chandler-Wirth, 1948, Univ. Calif. Syll. Ser. SS: 178.
Ambrysus mormon, La Rivers, 1949, Bull. So. Calif. Acad. Sci., 47 (3): 108; 1950, Pan-Pac. Entom., 26 (1): 19.

KEY TO SUBSPECIES

Embolium greatly inflated, width always more than 35 per cent of length....... *mormon mormon*
Embolium less inflated, width never attaining 35 per cent of length......... *mormon heidemanni*

Ambrysus mormon mormon Montandon

(Pl. 3, *h*; fig. 13, *h*)

General appearance.—The most variable species known to me. Medium to somewhat large, 9–12 mm. long, 6–9 mm. wide. Dorsum nearly always lighter anteriorly than it is posteriorly, often with a pronounced mottling of anterior portion of hemelytra; shiny but not polished, variously shagreened. Venter generally entirely yellowish to deep amber.

Head.—Light yellow through brown, some specimens with pronounced greenish tints, usually with some longitudinal brownish markings in center, and a bilobed brownish spot at posterior end often fused with the central markings; minutely, densely and shallowly punctulate, shiny; when oriented so that dorsal plane is perpendicular to line of vision (i.e., the greatest amount of dorsum exposed to view) front of head is seen to be slightly protuberant before eyes, with a suggestion of truncation. Eyes varying from black to gray, depending upon the vicissitudes of drying; inner and outer eye margins slightly curved outwardly, posterior margin strongly curved; viewed posteriorly, eyes only slightly protuberant above general head surface, the junction between the two forming a smooth but definite sinuosity. Head rather prominently sunken into anterior pronotal border. Labrum same color as front of head; ratio of length to width, 14:: 28 (50 per cent); mouthparts same color, darkening at tips. Head ratios are:

1) Total length to width (including eyes), 41:: 62 (66 per cent).
2) Anterior distance between eyes to posterior distance, 28:: 38 (74 per cent).
3) Posterior distance between eyes to greatest length of head posterior to this line, 38:: 14 (37 per cent).

Pronotum.—Shiny but not polished, conspicuously, densely, shallowly and roughly punctate with pronounced but weak incipient rugulosities demonstrable along nearly the entire anterior border, particularly behind region of deepest head penetration; ground color yellow to brownish, occasionally with considerable bright green developing laterally, usually with a variable development of brown mottling on disc varying from a brownish suffusion to a pattern of brown dots that varies from vague mottling to definite patterns—these consist of two brown areas on the disc, separated by a light V area which occupies the centrum—each brown spot is markedly angular, two angles situated anteriorly (separated by a V emargination), one at posterolateral edges and one at posterointernal edge, the whole giving the appearance of an inverted W with its base pointing cephalad and the entire letter solid brown with the exception of the bottom V; from this construction, the pattern fades to vague, barely discernible dark markings on some specimens. Thin, transverse, posterior pronotal line, as usual, separating the variegated disc from the broad, prominent, lighter, posterior pronotal border, which is generally whitish and set with many microscopic, black points. Lateral edges smooth, unserrate, occasionally, but not usually, with a sparse yellow pilosity; when head is firmly seated in anterior pronotal border, outer edge of pronotum and eye almost forms a smooth contour, the emargination produced at point of juncture negligible. Lateral pronotal curvature, expressed in terms of straight-line distance between anterior and posterior lateral angles and greatest vertical distance between this baseline and line of curvature, is 13 per cent (67:: 9). Posterolateral angles well rounded. Venter yellow to amber, no conspicuous darkening medially or posteriorly, but occasionally with bright green developing laterally. Dorsal pronotal ratios are:

1) Width between anterior angles to greatest pronotal width, 62:: 127 (49 per cent).
2) Median length to greatest width, 38:: 127 (30 per cent).

3) Width between anterior angles to distance between anterior angle and posterior base line of pronotum, 62 : : 58 (94 per cent).

Scutellum.—Brown, often with a reddish cast, to black, varying from only a slight lightening in color at posterior angle to a markedly mottled condition in which the light yellows constitute fully 50 per cent of the color; in this latter extreme, there are wide yellow areas at each of the three angles, as well as a longitudinal median stripe in the posterior half of the scutellum. Surface shiny, markedly rough-shagreened with dense, shallow, punctations, each puncture the seat of a white spot; in normal position, i.e., approximately on a plane surface with remainder of body, ratio of three sides, anterior and two laterals, is 84 : : 63 : : 62.

Hemelytra.—Deep brownish to jet black, usually with enough yellow spotting to give a mildly mottled effect; some greenish lights evident on certain individuals; when best developed, the yellow spots occur on embolium, at posterointernal margin of embolium at midedge of corium and membrane, and usually some lightening occurs on line between clavus and corium; this spotting may become almost totally eliminated except for the emboliar yellow, which is always present. Surface shiny but not polished, shagreened as is the scutellum. Embolium somewhat variable in proportions, but always very short and stout for the genus, i.e., strongly inflated, length to width varies from 55 : : 20 (36 per cent) to 72 : : 28 (39 per cent); prominently transversely bicolored, anterior two-thirds always bright yellow, posterior remainder dark brown to black; marginal pilosity lacking. Hemelytra rather strongly exposing lateral connexival edges, which are yellow to yellow brown or greenish, with or without prominent dark spots in region of connexival junctures, and with a variable amount of marginal, rather short, pilosity (the variation probably due to wear during the lifetime of the individual specimen). Posterolateral connexival angles always well developed, usually developed so strongly that in angle development they represent one of the maxima for the genus. Hemelytra do not quite reach, or just reach, abdominal tip.

Venter.—The prothoracic venter has been discussed above. Remainder of venter quite unicolorous with no prominent darkening; color varying from light yellow to deep amber to greenish laterally along abdomen and conspicuously about coxal plates; abdomen covered with the characteristic, yellowish, short, dense hydrofuge pelt; emboliar venter may or may not be discernibly bicolored longitudinally, but when so patterned, the outer margin is lighter. Connexival posterolateral angles are strongly spinose on all segments but segment I, which is entirely lacking in any angular prolongation whatsoever; connexival margins generally quite smooth, occasionally somewhat rough, but never distinctly dentate or serrate. Connexival border bearing spine increases progressively in width posteriorly in contradistinction to another condition so commonly found in the genus, viz., that in which the border is more or less uniform in width for most of its length, then bends rather abruptly inward under the shadow of the spine of adjacent segment. Female subgenital plate somewhat variable at apex, varying from more or less smoothly concave, the outer terminal "angles" well rounded, to a condition in which the concavity is armed with a prominent, caudally projecting tooth near the lateral terminal rounded "angle." Male genital hook long, narrow, well hooked to the left, very prominent.

Legs.—Prolegs: Coxa elongate, somewhat angularly globular, yellow through amber to green, smooth, flattened to receive heel of femur, distal edges darker. Trochanter well developed, smooth, shiny, yellow through amber to green, with a tuft of yellowish hairs distally on anterior end. Femur smooth, shiny, whitish yellow through amber to green, polished, widest near proximal end, and narrowing rapidly to distal end (i.e., with the characteristic incrassateness), compressed dorsoventrally, with typical short, very dense mat of hairs along front border which serves as a resting groove for tibia when closed against femur; ratio of length to greatest width of ventral surface is 54 : : 33 (62 per cent). Tibia very long, slender, smooth, yellow through amber to green, darkening apically, curved most strongly in distal part where, with the single tarsal segment, it forms a continuous, curved, grasping instrument—combined tibia-tarsus, when closed, just attaining, or slightly exceeding, adjacent (proximal) end of femur; tarsus darkening at tip.

Mesolegs: Coxa long, yellow to amber, occasionally with a greenish cast, somewhat angularly globular, equipped with short, dense, yellow pile, slightly curved from posterior end weakly laterad to anterior end, the outer face flat for reception of basal part of femur. Trochanter large, distinct, whitish yellow through amber to greenish, smooth distally, pilose proximally. Femur long, narrow, smooth, shiny, whitish yellow through amber to greenish, compressed dorsoventrally, weak and sparse setulosity on proximal third of outer or anterior edge; two rows of short, dense pile on

posterior (inner) face, representing, respectively, the posteroventral and posterodorsal corners; ratio of length to median width of ventral surface is 58: : 10 (17 per cent); length, 2.90 mm. Tibia whitish yellow through amber to greenish, smooth, shiny, long, narrow, bristling with reddish spines arranged in four longitudinal rows representing the four very weak "corners" of the tibia; ventrointernal (ventroposterior) row of spines consisting of single spines intermingled with very short, transverse rows of smaller spines; dorsal face proximally armed with a mat of long yellow hairs; distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row incomplete on outer or anterior edge, about two-thirds the length of complete, terminal row; ratio of length to median width of ventral surface is 48: : 6 (13 per cent); length, 2.30 mm. Tarsus smooth, long, narrow, whitish yellow through amber to green; spinose beneath, pilose ventrally and dorsally, terminating in two slender, yellow to amber claws, which darken at tips and are rather strongly curved.

Metalegs: Coxa swollen, globular, yellow through amber to green, well furred with short, dense, yellow pile, flattened ventrolaterally for reception of basal part of femur. Trochanter well developed, whitish yellow through amber to green, pilose proximally, smooth and shiny distally. Femur long, narrow, smooth, whitish yellow through amber to green, dorsoventrally compressed; sparse, short, reddish spination on outer (anterior) margin; inner (posterior) margin with two rows of reddish, chitinous points accompanied by short, dense pilosity, each row representing, respectively, the posteroventral and posterodorsal corners; markedly long pilosity on posterodorsal edge; ratio of length to median width is 74: : 13 (18 per cent); length, 3.45 mm. Tibia long, narrow, shiny, whitish yellow through amber to green, armed with four rows of reddish spines, the rows more or less equally spaced about the tibial circumference; a mat of dense, long yellow hairs occupying inner (posterior) face—distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row incomplete on outer or anterior edge, about two-thirds length of complete, terminal row; ratio of length to median width of ventral surface is 83: : 6 (7 per cent); length, 4.3 mm. Tarsus smooth, long, slender, whitish yellow through amber to green; spinose ventrally, pilose ventrally and inwardly, terminating in two yellowish claws, darkening at tips, rather strongly curved.

Type locality.—"Utah, St. Georges (Wickham)."

Location of type.—Montandon collection in the British Museum (Natural History).

Recorded distribution.—California, New Mexico, and Utah.

Material examined (see fig. 8).—ARIZONA: Gila Co., San Carlos, 17(viii)34, C. J. Drake (RLU); Yavapai Co., Camp Verde, 2(ix)38, C. L. Hubbs and family (UM). CALIFORNIA: Alameda Co., Livermore, 14(ix)30, 17(iv)34, R. L. Usinger; Niles Canyon, 17(ix)38, R. L. Usinger, and 30(ix)38, P. H. Baldwin (RLU); Calaveras Co., Mokelumne Hill, 30(v)31, R. L. Usinger; Twain Harte, 1(iv)33, H. E. Hinton (RLU); Humboldt Co., Eel River, 6 mi. N of Garberville; Ettersburg, 19(vii)25; Garberville, 1(vi)30, P. H. Baldwin; Mattole River near Petrolia, 7(viii)29, J. Gregory (RLU); Inyo Co., Lone Pine, 10(vi)29, R. L. Usinger (RLU); Lake Co., Clear Lake, (xi)27; Lakeport, 28(v)33; Lower Blue Lake, 2(xi)37, H. P. Chandler; Thurston Lakes, 6(ix)46, H. P. Chandler (RLU); Mariposa Co., Bear Creek (Indian Gulch), 3(iii)40, B. E. White (RLU); Mendocino Co., Comfort, (vi)06 (RLU); Mono Co., Benton, 28(vii)38, C. L. Hubbs and family (UM); Mammoth Lakes, 29(vii)40, L. C. Kuitert (UK); Monterey Co., Santa Lucia Mountains, 2(iv)20, B. C. Cain (RLU); Napa Co., Monticello, 12(vi)36, J. J. du Bois; Pope Valley, 23(vi)42, R. L. Usinger (RLU); Placer Co., Auburn, 28(vii)32, R. L. Usinger (RLU); Santa Clara Co., Hecker Pass, 5(vii)47, K. S. Hagen (RLU); Shasta Co., Clear Creek, 15 mi. W of Redding, 17(ix)46, H. P. Chandler (RLU); Sonoma Co., Austin Creek (trib. Russian River) near Monte Rio, 1(i)41, B. W. and H. B. Walker; Gualala River, 15 mi. from mouth, 1(i)41, B. W. and H. B. Walker (UM); Stanislaus Co., Knight's Ferry, 24(ix)32; Oakdale, 4(vi)32, (x)31, E. Washburn (RLU); Yolo Co., Davis, 26(vi)32, 3(vii)32, R. L. Usinger; Winters, 22(vii)46, H. P. Chandler (RLU). COLORADO: Huerfano Co., Walsenburg, 13(viii)25, F. M. Gaige (UM); La Plata Co., Bayfield, 4(vii)37, C. L. Johnson (UK); Moffatt Co., Craig, 18(viii)40, L. C. Kuitert (UK); Ottawa Co., Lamar, 22(ix)26, Hubbs-Schultz (UM). NEVADA: Clark Co., Muddy River at Moapa, 12(vii)38, C. L. Hubbs and family (UM); Eureka Co., Pony Creek, 12(viii)38, C. L. Hubbs and family (UM); Lincoln Co., Panaca, 10(vii)38, C. L. Hubbs and family (UM); Mineral Co., Walker Lake, (x)33, G. D. Hanna (RLU); Nye Co., Riordan, 27(viii)38, C. L. Hubbs and family; White River Valley, 28(viii)38, C. L. Hubbs and family(UM); Washoe Co., Pyramid Lake(Anaho

Island), 29(v)24, E. R. Hall (RLU), (Fremont Point), 16(viii)49, -LaR (LaR), (Sutcliffe), 24(vii)24, E. R. Hall (RLU); Reno, 21(xi)39, -LaR (LaR). NEW MEXICO: Mora Co., Watrous (Mora Rivera), 21(ix)26, Hubbs-Schultz (UM). SOUTH DAKOTA: Fall River Co., Cascade Springs (Black Hills), 30(vii)35, H. C. Severin (RLU); Pennington Co., Hill City, P. R. Uhler collection (USNM); Shannon Co., White River, 7(vii)34, C. L. Hubbs (UM); Todd Co., Rosebud Indian Reservation, 7(vii)34, C. L. Hubbs (UM). UTAH: San Juan Co., Bridge Canyon, 6(vii)33, R. L. Usinger (RLU); Utah Co., Spanish Fork, 15(viii)40, E. E. Kenaga-L. C. Kuitert (RLU); Washington Co., Enterprise Reservoir, 4(vii)38, C. L. Hubbs and family (UM); St. George, July, Wickenham, 23(iv)30, L. R. Woodbury (RLU). WYOMING: Yellowstone National Park, Geyser Basin, P. R. Uhler collection (USNM); Caribou Co., N. Platte River, 17(ix)34, C. L. Hubbs and family (UM); Weston Co., Beaver Creek, 9(vii)34, C. L. Hubbs (UM).

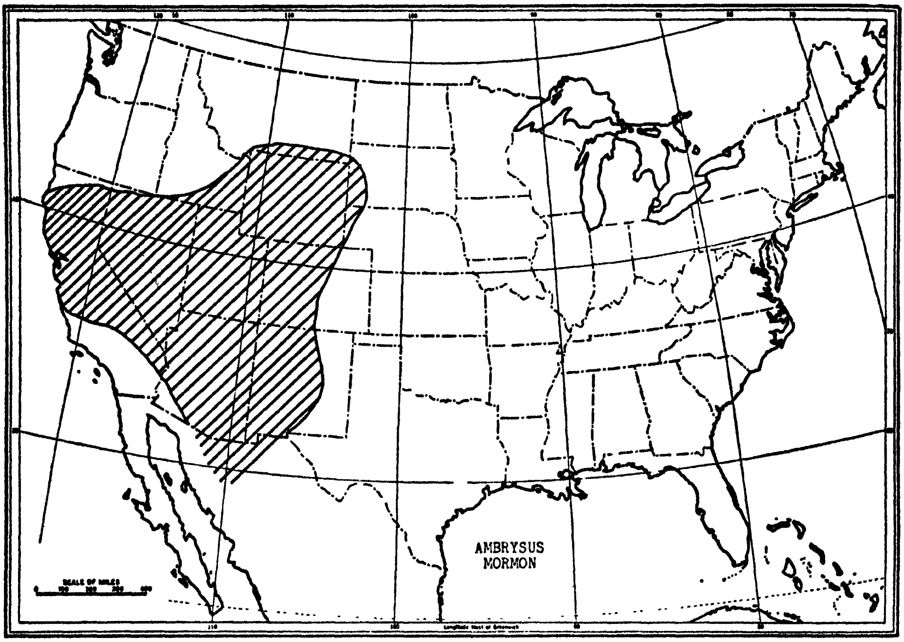

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Fig. 8. Distribution of *Ambrysus mormon.*

Ambrysus mormon heidemanni Montandon

(Pl. 3, *i*; fig. 13, *i*)

Ambrysus heidemanni Montandon, 1910, Bull. Soc. Sci. Buc.-Roum., 18 (5–6): 188.
Ambrysus heidemanni, Van Duzee, 1917, Univ. Calif. Publ. Entom., 2: 459.
Ambrysus heidemanni, Hungerford, 1919, Bull. Univ. Kans., Sci. Bull., 11: 205.
Ambrysus heidemanni, Usinger, 1946, Bull. Univ. Kans., Sci. Bull., 31 (1): 186.

This is identical with the typical subspecies except that (1) it is distinctly reduced in size, being a diminutive replica of *A. m. mormon*, 8.5–9 mm. long by 5–6 mm. wide; (2) its embolium is comparatively longer and narrower, less inflated, and in ratio of length to width never exceeds 35 per cent (av. 98 : : 31 = 32 per cent); (3) its female subgenital plate slightly but insignificantly differs from typical *A. m. mormon* in that the concavity at the tip occupies a wider area at end of tip and so reduces the usual rounded, lateral "angles" to the status of blunt angles. The male genital process is indistinguishable from the typical subspecies.

This form was described from the warm mineral waters of Yellowstone National Park; until more information is forthcoming to the contrary, *A. m. heidemanni* can only be regarded as an ecotype that retains its individuality because it has some degree of isolation in warm waters; in all cases, such thermal environments grade imperceptibly into normal waters so that a constant, even though somewhat restricted, interplay of genes is possible between populations in the two environments. In fact, enough material is at hand from similar isolated thermal areas in the western Great Basin to suggest that the structural changes present in *A. m. heidemanni* are repeated by other segments of the *A. mormon* population whenever the conditions of the environment approach or correspond to those at Yellowstone. In all probability, *A. m. heidemanni* is not even worthy of a name, and the term itself should be placed in synonymy, but some additional field work is necessary to completely settle the point.

Type locality.—"Yellowstone Park, dans les flaques d'eau des geysers."

Location of type.—Montandon collection in the British Museum (Natural History).

Recorded distribution.—Yellowstone National Park, Wyoming.

Material examined (see fig. 8).—WYOMING: Yellowstone National Park, Inkwell, 1930, C. T. Brues; Norris Geyser Basin, 6(viii)30, R. L. Usinger; Old Faithful, 3(viii)30, R. L. Usinger; Tangle Creek, 1930, C. T. Brues (RLU).

Ambrysus woodburyi Usinger

(Pl. 3, *j*; fig. 13, *j*)

Ambrysus woodburyi Usinger, 1946, Bull. Univ. Kans., Sci. Bull., 31 (1) : 194.
Ambrysus woodburyi, La Rivers, 1949, Bull. So. Calif. Acad. Sci., 47 (3) : 108.

General appearance.—A rather small species, with no contrasting mottling of importance, 7.5–8.5 mm. long and 5–6 mm. wide. Dorsum rather dull-colored, blackish posteriorly, yellowish anteriorly, shiny. Venter with abdomen much lighter in color than remainder of body.

Head.—Yellow to reddish brown to greenish, with a variable head-pattern development. Generally, a median longitudinal streak, brownish or greenish, is discernible, which increases in size posteriorly, narrowing anteriorly; the median pattern is composed of a basic brownish suffusion upon which two rows of brownish or greenish dots are superimposed; in some individuals with reddish-brown heads, the central pattern is completely obliterated. Surface shiny, minutely roughened and punctulate. When oriented so that dorsal plane is perpendicular to line of vision (i.e., the greatest amount of dorsum exposed to view), front of head is seen to be slightly protuberant before eyes, and with a suggestion of truncation. Eyes black to gray, depending upon the conditions of drying; outer and inner margins very slightly rounded, posterior margin very strongly curved; viewed posteriorly, eyes absolutely flush with head surface, no protuberance evident. Head broadly and very deeply inserted into anterior pronotal border. Labrum same color as front of head; ratio of length to width, 16: : 32 (50 per cent); mouthparts darkening at tip. Head ratios are:

1) Total length to width (including eyes), 62: : 89 (70 per cent).
2) Anterior distance between eyes to posterior distance, 46: : 59 (78 per cent).
3) Posterior distance between eyes to greatest length of head posterior to this line, 59: : 21 (36 per cent).

Pronotum.—Shiny but minutely, almost smoothly, roughened and punctate, incipient transverse rugulosities developing centrally behind region of deepest head penetration. Ground color yellow brown, in some specimens becoming either yellow or green laterally; disc generously but often obscurely beset with dark brown dots except on the median line, where a rather wide, V-shaped area extending anteriorly to head base is free from dotting; often conspicuously light yellow spots at the two anterolateral angles and in the vicinity of posterolateral angles. Broad, whitish to greenish, posterior pronotal border conspicuously separated by transverse, thin, blackish posterior pronotal line (interrupted in middle) from varicolored disc. Lateral edges smooth, unser-

rate, in unrubbed specimens with sparse, barely discernible marginal pilosity. Pronotal lateral curvature, expressed in terms of straight-line distance between anterior and posterior lateral angles and greatest vertical distance between this baseline and line of curvature, is 17 per cent (87:: 15). Posterolateral angles well rounded. Venter blackish, lighter laterally; conspicuous golden pilosity along posterior margin and on keel. Dorsal pronotal ratios are:

1) Width between anterior angles to greatest pronotal width, 47:: 89 (53 per cent).

2) Median length to greatest width, 28:: 89 (32 per cent).

3) Width between anterior angles to distance between anterior angle and posterior base line of pronotum, 47:: 42 (89 per cent).

Scutellum.—Generally uniformly dark reddish brown, often with a lightening in color at all, or only posterior, angles. Shiny but not polished, shagreened with dense, shallow punctation, each puncture the seat of a white spot. In normal position, i.e., approximately on a plane surface with remainder of body, ratio of three sides, anterior and two laterals, is 55:: 41:: 40.

Hemelytra.—Uniformly, immaculately, deep reddish brown to blackish, often with a greenish tinge, light spots only in emboliar regions. Surface shiny but not polished, shagreened as in scutellum. Embolium approximately average in width and length for the genus (length to width, 147:: 50 = 34 per cent), rarely with detectable, sparse, marginal pilosity; anterior two-thirds light in color, posterior part dark. Hemelytra rather strongly exposing lateral connexival margins, which are yellowish or greenish, with conspicuous darkening at connexival junctures; conspicuous pilosity marginally in unrubbed specimens. Posterolateral connexival angles inconspicuously but distinctly spinose. Hemelytra fully, or not quite, attaining abdominal tip.

Venter.—The prothoracic venter has been discussed above. Remainder of venter very strongly and distinctly bicolored, the abdomen golden yellow by virtue of its pelt of dense, short, hydrofuge pile which is lacking on most of the dark reddish-brown mesosternum and metasternum; no suggestion of any dark spotting laterally at connexival junctures. Emboliar venter may or may not be somewhat lighter along lateral margin. Connexival posterolateral angles show considerable variations in spinosity, both as to length of individual spines and the degree to which they project laterad from the connexival margins; greenish specimens show the greatest spinal development, and laterad projection, whereas brownish individuals examined have smaller spines which lie more nearly parallel to the general connexival margin; all angles are spinose except those of segment I; angles may or may not be darker than border. Connexival margins somewhat variable, either more or less smooth or unevenly and irregularly serrate, except segment I; connexival borders narrow but more or less subparallel for most of their lengths, then dipping rather rapidly inward under shadow of adjacent connexival spines. Female subgenital plate quite diagnostically trifid at apex, the central process fairly sharp, but rounded, the lateral processes quite sharp and spinose. Male genital hook also quite characteristically U-shaped.

Legs.—Prolegs: Coxa elongate, somewhat angularly globular, yellowish to greenish, smooth, flattened to receive heel of femur, distal edges slightly darker. Trochanter well developed, smooth, shiny, same color as coxa, with a tuft of whitish hairs distally on anterior end. Femur smooth, yellow to green, polished, widest near proximal end, narrowing rapidly to distal end (i.e., with the characteristic swollen, incrassate appearance), compressed dorsoventrally, with typical short, dense mat of hairs along front border which serves as a resting groove for tibia when closed against femur; ratio of length to greatest width of ventral surface is 84:: 53 (63 per cent). Tibia long, slender, smooth, amber to green, darkening apically, curved most strongly in distal part where, with the single tarsal segment, it forms a continuous, curved, grasping instrument—combined tibia-tarsus, when closed, generally distinctly exceeding adjacent (proximal) end of femur. Tarsus darkening at tip.

Mesolegs: Coxa long, somewhat angularly globular, deep amber to greenish, equipped with short, dense, whitish pile, slightly curved from posterior end weakly to anterior end, the outer face flat for reception of basal part of femur. Trochanter large, same color as coxa, smooth distally, pilose proximally. Femur long, narrow, yellow to green, compressed dorsoventrally, weak and sparse setulosity on outer or anterior edge; a row of short, reddish, chitinous points on dorsointernal (dorsoposterior) margin; ratio of length to median width of ventral surface is 81:: 16 (20 per cent); length, 2.0 mm. Tibia same color as femur, smooth, shiny, long, narrow, bristling with reddish spines arranged in four longitudinal rows representing the four very weak "corners" of tibia; ventrointernal (ventroposterior) row of spines consisting of single spines alternating

with very short, transverse rows of smaller spines; dorsal face proximally clothed with a mat of long, whitish hairs; distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row incomplete on outer or anterior edge, half or slightly more than half the length of terminal row; ratio of length to median width of ventral surface is 72: : 9 (13 per cent); length, 1.90 mm. Tarsus smooth, long, narrow, same color as tibia, pilose and setose ventrally, terminating in two slender, amber to greenish claws, darkening at tips, and moderately curved.

Metalegs: Coxa swollen, globular, amber to green, well furred with short, dense, golden pile, flattened ventrolaterally for reception of basal part of femur. Trochanter well developed, same color as coxa, pilose proximally, smooth and shiny distally. Femur long, narrow, smooth, yellow to greenish, dorsoventrally compressed; prominent, short, reddish spination on outer (anterior) margin; inner (posterior) margin with a row of reddish chitinous points dorsally and ventrally,

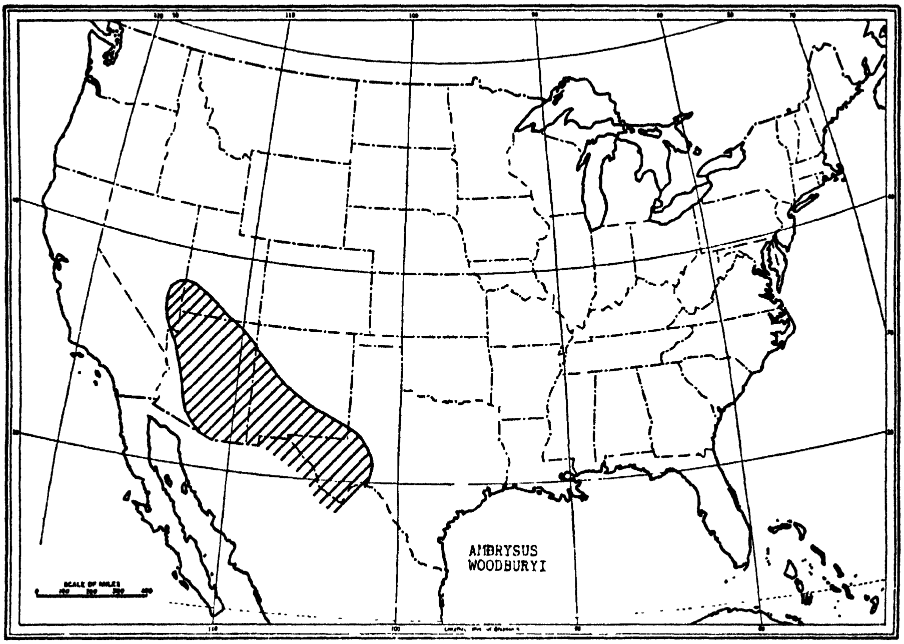

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Fig. 9. Distribution of *Ambrysus woodburyi*.

the latter accompanied and often almost obscured by a short, dense file of whitish pile; markedly long pilosity on posterodorsal edge; ratio of length to median width is 97: : 17 (18 per cent); length, 2.45 mm. Tibia long, narrow, shiny, same color as femur, armed with four rows of reddish spines, the rows more or less equally spaced about tibial circumference; a mat of dense, long, golden amber hairs occupying inner (posterior) face—distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row incomplete, only half or slightly more than half the length of complete, terminal row; ratio of length to median width of ventral surface is 111: : 8 (7 per cent); length, 3.0 mm. Tarsus smooth, long, same color as tibia; spinose and pilose ventrally, terminating in two amber to slightly greenish claws, darkening at tips and moderately curved.

Type locality.—"Zion National Park, Utah, A. M. Woodbury collector."

Location of types.—"Holotype, male, and allotype, female (California Academy of Sciences)." Other paratypes are designated from Moab, Utah, and Sunnyside, Nevada.

Recorded distribution.—Arizona, southern Nevada, and southern Utah.

Material examined (see fig. 9).—ARIZONA: Cochise Co., Cave Creek, 20(vi)29, J. O. Martin (RLU); Oak Creek Canyon, 9(vii)41, B. Hodgen (UK). NEVADA: Nye Co., Sunnyside, 1930,

C. T. Brues (RLU). New Mexico: Jemez Springs, 1(vii)41, R. H. Beamer (UK). Texas: Davis Mountains, 12(vii)38, R. I. Sailer (UK). Utah: Grand Co., Moab, W. J. Gertsch (RLU); Zion National Park, 9(vi)37 (RLU).

Ambrysus arizonus, n. sp.

(Pl. 3, *k*; fig. 13, *k*)

General appearance.—Rather large species, with a tendency to broadness, 11–14 mm. long, 8–9 mm. wide. Dorsum bicolored, light anteriorly and laterally, dark posteriorly, entire surface punctate, more finely and conspicuously so posteriorly, shiny. Venter darker anteriorly, lighter posteriorly.

Head.—Light to greenish yellow, shiny, essentially impunctate, broadly truncate and slightly protuberant between eyes. Eyes dark brown in considerable contrast to ground color of head, essentially flush with head surface, inner and outer eye margins nearly straight, posterior margin strongly curved. Head rather definitely sunken into anterior median pronotal border. Labrum same color as front of head; ratio of length to width, 5: : 10 (50 per cent); mouthparts same color, darkening at tips. Head ratios are:

1) Total length to width (including eyes), 27: : 40 (68 per cent).

2) Anterior distance between eyes to posterior distance, 19: : 25 (76 per cent).

3) Posterior distance between eyes to greatest length of head posterior to this line, 25: : 7 (28 per cent).

Pronotum. Shiny but not polished, conspicuously, densely, shallowly, and roughly punctate with pronounced but weak incipient rugulosities manifest along nearly the entire anterior border, particularly behind region of deepest head penetration; ground color yellowish to whitish, occasionally with a faint greenish cast, usually with a varying degree of brown mottling on disc, ranging from a brownish suffusion to a definite pattern of brown dots; such patterns vary from a simple mottling to a definite pattern consisting of two brown areas on the disc, separated by a light V area which occupies the centrum, each brown spot is markedly angular, two angles anteriorly (separated by a V emargination), one at posterolateral edge and one at posterointernal edge, the whole giving the appearance of an inverted W with its base pointing cephalad, the entire letter solid brown with the exception of the bottom V; from this construction, the pattern fades to vague, barely discernible, dark markings on some specimens. Thin, transverse, posterior pronotal line, as usual, separating the variegated disc from the broad, prominent, lighter posterior pronotal border, which is generally whitish, set with many microscopic black points. Lateral edges smooth, nonserrate, with rare yellow pilosity; when head is firmly seated in anterior medial pronotal border, outer edge of pronotum and eye almost forms a smooth contour, the emargination produced at point of juncture being negligible. Lateral pronotal curvature, expressed in terms of straight-line distance between anterior and posterior lateral angles and greatest vertical distance between this base line and line of curvature, is 17 per cent (48: : 8). Posterolateral angles well rounded. Venter light yellowish, often with a greenish cast, and some darkening anterolaterally. Dorsal pronotal ratios are:

1) Width between anterior angles to greatest pronotal width, 41: : 94 (44 per cent).

2) Median length to greatest width, 31: : 94 (32 per cent).

3) Width between anterior angles to distance between anterior angle and posterior base line of pronotum, 41: : 44 (93 per cent).

Scutellum.—Reddish brown with light edges; surface shiny, markedly rough-shagreened with dense, shallow punctations, each puncture seating a white spot; in normal position, i.e., approximately on a plane surface with remainder of body, ratio of three sides, anterior and two laterals, is 56: : 44: : 44.

Hemelytra.—Brown to blackish, with only faint, sparse mottling, scarcely evident usually; surface shiny but not polished, shagreened as is the scutellum. Embolium stout for the genus, length to width 48: : 18 (=38 per cent), prominently transversely bicolored, anterior two-thirds to three-fourths light yellow, posterior remainder dark brown to black; marginal pilosity absent. Hemelytra strongly exposing lateral connexival edges, which are yellow to yellow brown, with prominent dark spots in region of connexival junctures; marginal pilosity present and conspicuous. Posterolateral connexival angles always well developed, strong; hemelytra just, or not quite, attaining abdominal apex.

Venter.—The prothoracic venter has been discussed above. Remainder of venter quite unicolorous with no prominent darkening except faintly along the major sutures; color varying shades of yellow; abdomen covered with the characteristic yellowish, short, dense, hydrofuge pelt; emboliar venter longitudinally bicolored, externally light, internally dark. Connexival posterolateral angles strongly spinose on all segments but I, which is minutely sharp-angulate; connexival margins irregularly roughened so as to appear serrate in most specimens on segments III to IV, smoother on segment II. Connexival border bearing the posterolateral spine increases progressively in width posteriorly in contradistinction to another condition so commonly found in the genus, viz., that in which the border is more or less uniform in width throughout most of its length, then bends more or less abruptly inward under shadow of spine of adjacent segment. Female subgenital plate distinctly and conspicuously quadrisinuate in outline at tip, the outer sinuosities rather blunt-angulate, the two median sinuosities low and about even with the line connecting the two lateral angles; male genital process slim, narrowing to apex, long, and usually quite straight in contrast to most of the genus, occasionally slightly bent externally.

Legs.—Prolegs: Coxa elongate, somewhat angularly globular, yellow to amber, smooth, flattened to receive femoral heel, distal edges darker. Trochanter well developed, smooth, shiny, yellow to amber, with a tuft of yellowish hairs distally on anterior end. Femur smooth, shiny, yellowish, polished, widest near proximal end, and narrowing rapidly to distal end (i.e., incrassate), compressed dorsoventrally, with typical short, dense mat of hairs along front border which serves as a resting groove for tibia when closed against femur; ratio of length to greatest width of ventral surface is 38: : 26 (68 per cent). Tibia very long, slender, smooth, yellow, darkening apically, curved most strongly in distal part where, with the single tarsal segment, it forms a continuous, curved, grasping instrument—combined tibia-tarsus, when closed, just attaining, or slightly exceeding, adjacent (proximal) end of femur. Tarsus darkening at tip.

Mesolegs: Coxa long, yellowish, somewhat angularly globular, equipped with short, dense, yellow pile, slightly curved from posterior end weakly laterad to anterior end, the outer face flat for reception of femoral base. Trochanter large, distinct, yellowish, smooth distally, pilose proximally. Femur long, narrow, smooth, shiny, yellow, compressed dorsoventrally, weak and sparse setulosity on proximal third of outer or anterior edge; two rows of short, dense pile on posterior (inner) face, representing, respectively, the posteroventral and posterodorsal corners; ratio of length to median width of ventral surface is 43: : 8 (19 per cent); length, 3.25 mm. Tibia yellowish, smooth, shiny, long, narrow, bristling with reddish spines arranged in four longitudinal rows representing the four very weak "corners" of the tibia; ventrointernal (ventroposterior) row of spines consisting of single spines intermingled with very short, transverse rows of shorter spines; dorsal face proximally armed with a mat of long yellow hairs; distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row incomplete on outer or anterior face, about two-thirds length of complete, terminal row; ratio of length to median width of ventral surface is 40: : 5 (13 per cent); length, 3 mm. Tarsus smooth, long, narrow, yellowish, spinose beneath, pilose ventrally and dorsally, terminating in two slender, well-curved, yellow claws, darkening at tips.

Metalegs: Coxa swollen, globular, yellow, well furred with short, dense, yellow pile, flattened ventrolaterally for reception of basal part of femur. Trochanter well developed, yellow, pilose proximally, smooth and shiny distally. Femur long, narrow, smooth, yellow, dorsoventrally compressed; sparse short reddish spination on outer (anterior) margin; inner (posterior) margin with two rows of reddish, chitinous points, accompanied by short, dense pilosity, each point representing, respectively, the posteroventral and posterodorsal corners; markedly long pilosity on posterodorsal edge; ratio of length to median width is 55: : 9 (16 per cent); length, 4 mm. Tibia long, narrow, shiny, yellow, armed with four rows of reddish spines, the rows more or less equally spaced about the tibial circumference; a mat of dense, long yellow hairs occupying inner (posterior) face—distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row incomplete on outer or anterior edge, about two-thirds length of complete, terminal row (this secondary row is occasionally essentially complete across the tibial width); ratio of length to median width of ventral surface is 62: : 5 (8 per cent); length, 4.6 mm. Tarsus smooth, long, slender, yellow, spinose ventrally, pilose ventrally and inwardly, terminating in two yellowish claws, darkening at tips and rather strongly curved.

Type locality.—ARIZONA: Pinal Co., Florence, 26(vii)03, C. R. Biederman (UK).

Location of types.—Holotype male and allotype in collection of Snow Museum, University of Kansas at Lawrence; 8 paratypes at University of Michigan, Ann Arbor.

Recorded distribution.—None.

Material examined (see fig. 10).—ARIZONA: Cochise Co., San Pedro River at U.S. 92 near Bisbee, 13(vii)39, Miller-Davis; Tombstone (San Pedro River), 13(vii)39, Miller-Davis (UM); Gila Co., Tonto Creek, 15(ix)26, Hubbs-Schultz (UM); Pima Co., Tucson (Santa Cruz River), 12(vii)39, Miller-Davis (UM) Yavapai Co., Camp Verde, 2(ix)38, C. L. Hubbs and family (UM); type locality. All the material listed is paratypic.

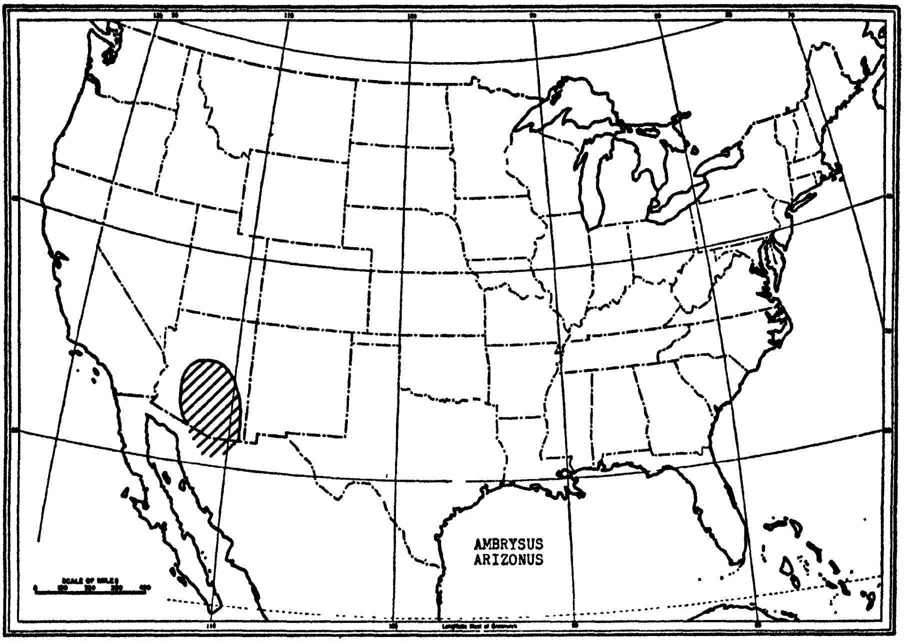

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Fig. 10. Distribution of *Ambrysus arizonus.*

Ambrysus occidentalis, n. sp.

(Pl. 4, *l;* fig. 13, *l*)

General appearance.—A strongly contrastingly mottled species, of rather more than medium size, 10–12.5 mm. long, 7–8.25 mm. wide. Dorsum strongly mottled with yellow and brown, often with a greenish cast, shiny, somewhat lighter anteriorly, darker posteriorly. Venter rich golden yellow, often with a strong greenish tinge, commonly with vague, darker spots at lateral connexival angles of abdomen.

Head.—Ground color whitish yellow to deep yellow or green with a variable development of deep brownish or blackish spotting and streaking; when best developed, this streaking takes the form of two median longitudinal series of dots, enlarging posteriorly and generally isolated, although often fusing posteriorly with two brown or blackish spots at base of head; subdermal streaking, much paler, is usually apparent on each side of median streaking, enlarging anteriorly; lateral head margins with irregular brown areas fusing posteriorly with the two basal head spots. Surface shiny, smooth, minutely punctulate. When oriented so that dorsal plane is perpendicular to line of vision (i.e., the greatest amount of dorsum exposed to view) front of head is seen to be slightly protuberant before eyes, with a faint suggestion of truncation. Eyes black to white, depending upon the idiosyncrasies of drying; outer margin essentially straight, inner slightly curved, posterior strongly curved; viewed posteriorly, eyes essentially flush with head surface,

no protuberance evident. Head broadly and rather shallowly seated in anterior pronotal border. Labrum same color as head front; ratio of length to width, 50: : 22 (44 per cent); mouthparts darkening at tip. Head ratios are:

1) Total length to width (including eyes), 84: : 132 (69 per cent).

2) Anterior distance between eyes to posterior distance, 70: : 82 (85 per cent).

3) Posterior distance between eyes to greatest length of head posterior to this line, 82: : 20 (24 per cent).

Pronotum.—Shiny, smooth, minutely punctate, incipient transverse rugulosities developing centrally behind region of deepest head penetration. Ground color various shades of yellow to green; a variable development of brown to blackish mottling and dotting on disc; the best-developed pattern consists of two irregular triangles, each occupying a half of disc, leaving free a V-shaped area medianly and anteriorly—the posterior sides of triangles sharply delineated by the thin, transverse, posterior pronotal line, lateral sides of triangles much vaguer—concentration of dotting occurs in three angles of each triangle; V-shaped area with two oblong, brownish-to-blackish spots anteriorly, occasionally very greatly faded. Broad, whitish, posterior pronotal border conspicuously separated by transverse line (interrupted in middle) from varicolored disc. Lateral edges smooth, unserrate, very weakly pilose marginally in unrubbed specimens; when head is firmly seated in anterior pronotal border, outer edge of pronotum and eye forms an essentially smooth contour, i.e., the emargination caused by the junctures is nonexistent or insignificant. Pronotal lateral curvature, expressed in terms of straight-line distance between anterior and posterior lateral angles and greatest vertical distance between this base line and line of curvature, is 15 per cent (65: : 10). Posterolateral angles quasi-distinct, not entirely lost in the general rounding. Venter yellowish to greenish, the greenish color being most pronounced laterally; vague darkenings laterally behind eye; conspicuous whitish-to-yellow pilosity along posterior margin and on keel. Dorsal pronotal ratios are:

1) Width between anterior angles to width between posterior angles, 70: : 133 (53 per cent).

2) Median length to greatest width, 48: : 133 (36 per cent).

3) Width between anterior angles to distance between anterior angle and posterior base line of pronotum, 70: : 62 (89 per cent).

Scutellum.—Dark reddish brown to blackish, conspicuously marked with yellow along lateral edges and generally with a complete median longitudinal stripe of yellow which may be reduced to a median spot. Shiny but not polished, shagreened with dense, shallow punctation, each puncture the seat of a white spot. In normal position, i.e., approximately on a plane surface with remainder of body, ratio of three sides, anterior and two laterals, is 85: : 60: : 59.

Hemelytra.—Strongly and contrastingly mottled with blackish brown and yellow or green; when best developed, the pattern of light spots consists of a large, light area on embolium, a generally slightly darker, irregular light spot at posterointernal emboliar angle, a light border along anterior two-thirds of corium-membrane juncture, wider posteriorly and giving rise to a forward-projecting branch medially; a wide, vague, light area adjacent to outer hemelytral border; clavus light along sutures and medially. The pattern described may be markedly reduced but is usually recognizable. Surface shiny but not polished, shagreened as is scutellum. Embolium somewhat short and stout for the genus (length to width, 148: : 54 = 37 per cent), rarely with detectable, marginal (always sparse) pilosity; anterior two-thirds to three-fourths yellowish, amber, or greenish, posterior part dark brown. Hemelytra very strongly exposing lateral connexival margins, which are yellowish or greenish, with dark spots at connexival junctures, conspicuous marginal pilosity in unrubbed specimens. Posterolateral connexival angles moderately prominent, spinose to angulate-produced. Hemelytra attaining abdominal tip.

Venter.—The prothoracic venter has been discussed above. Remainder of venter whitish to amber, often with a greenish tinge laterally and anteriorly, without dark spotting except marginally along connexival juncture, these spots usually vague; venter either more or less uniform in color or distinctly bicolored, the abdomen lighter than remainder by virtue of the dense, golden hydrofuge pelt covering the basically darker, yellow to amber color, which, however, shows through readily on the sparsely haired mesosternum and metasternum. Emboliar venter nearly always discernibly longitudinally bicolored, the outer half lighter. Connexival posterolateral angles somewhat variable, from strongly angulate-produced to definitely spinose, except those of segment I, which are, at most, but slightly right-angulate, generally quite blunt, and not at all pro-

duced; angles distinctly and contrastingly darker than remainder of connexival border. Connexival margins distinctly, strongly, but somewhat minutely dentate or serrate on all segments except segment I, although an occasional individual specimen is found with more or less smooth borders; connexival border subparallel for most of its length, then dipping inward abruptly under shadow of spine of adjacent segment. Female subgenital plate nondiagnostically quadrisinuate at apex, all sinuosities more or less equal in development, the outer two occasionally sharper, more angulate. Male genital hook short, broad, platelike, with a strong left lean and angulate or aborted "toe."

Legs.—Prolegs: Coxa elongate, somewhat angularly globular, whitish, yellowish, greenish, smooth, flattened to receive heel of femur, distal edges slightly darker. Trochanter well developed, smooth, shiny, same color as coxa, with a tuft of whitish or yellowish hairs distally on anterior end. Femur smooth, white, yellow or green, polished, widest near proximal end, narrowing rapidly to distal end (i.e., typically incrassate), compressed dorsoventrally, with typical short, very dense mat of hairs along front border which serves as a resting groove for tibia when closed against femur; ratio of length to greatest width of ventral surface is 103:: 73 (71 per cent). Tibia long, slender, smooth, whitish yellow through amber to green, darkening apically, curved most strongly in distal part where, with the single tarsal segment, it forms a continuous, curved, grasping instrument—combined tibia-tarsus, when closed, just attaining adjacent (proximal) end of femur. Tarsus darkening at tip.

Mesolegs: Coxa long, somewhat angularly globular, whitish, yellow through amber to green, equipped with short, dense, whitish pile, slightly curved from posterior end weakly to anterior end, the outer face flat for reception of basal part of femur. Trochanter large, same color as coxa, smooth distally, pilose proximally. Femur long, narrow, smooth, shiny, white, yellow, green, compressed dorsoventrally, weak and sparse setulosity on outer or anterior edge, markedly decreasing in size distally; a row of short, reddish, chitinous points on dorsointernal (dorsoposterior) margin; ratio of length to median width of ventral surface is 108:: 25 (23 per cent); length, 2.55 mm. Tibia same color as femur, smooth, shiny, long, narrow, bristling with reddish spines arranged in four longitudinal rows representing the four very weak "corners" of tibia; ventrointernal (ventroposterior) row of spines consisting of single spines alternating with very short, transverse rows of smaller spines; dorsal face proximally clothed with a mat of long, whitish hair; distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row incomplete on outer or anterior edge, slightly more than half the length of terminal row; ratio of length to median width of ventral surface is 98:: 12 (12 per cent); length, 2.55 mm. Tarsus smooth, long, narrow, same color as tibia, pilose and setulose ventrally; terminating in two slender, whitish, yellowish, or greenish claws, darkening at tips and moderately curved.

Metalegs: Coxa swollen, globular, white, yellow, or green, well furred with short, dense, whitish pile, flattened ventrolaterally for reception of basal part of femur. Trochanter large, same color as coxa, pilose proximally, smooth and shiny distally. Femur long, narrow, smooth, white, yellow or greenish, dorsoventrally compressed; sparse, short, reddish spination on outer (anterior) margin; inner (posterior) margin with a row of reddish chitinous points dorsally, and short, dense pilosity (which may be rubbed) ventrally; markedly long pilosity on posterodorsal edge; ratio of length to median width is 148:: 27 (18 per cent); length, 3.60 mm. Tibia long, narrow, shiny, same color as femur, armed with four rows of reddish spines, the rows more or less equally spaced about the tibial circumference; a mat of dense, long, dirty whitish hairs occupying inner (posterior) face—distal end ventrally with two prominent, transverse, rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row only half (or slightly more) the length of complete, terminal row; ratio of length to median width of ventral surface is 85:: 7 (8 per cent); length, 4.0 mm. Tarsus smooth, long, same color as tibia; spinose and pilose ventrally, terminating in two whitish to amber, or greenish, claws, rather weakly curved and darkening at tips.

Type locality.—ARIZONA: Cochise Co., 29(vii)27, R. H. Beamer (UK). No specific locality is given on the collecting labels, but since this is the largest and most representative series available, and Cochise County is not a very large area, no real problems are likely to result from this omission.

Location of types.—Holotype male, allotype and a large series of paratypes in the Snow Museum, University of Kansas at Lawrence; a large series of paratypes in the collection of the University of Michigan Museum of Zoölogy at Ann Arbor; one paratype in the collection of the U.S. National Museum.

Recorded distribution.—This is undoubtedly the species which has been severally and variously listed as "*Ambrysus signoreti*" for the United States. It is visually quite distinct from *A. arizonus*, with which it occurs, bearing a strong superficial resemblance to the more eastern *A. lunatus*; all three species are easily separable on the basis of the external genitalic accessories. "*A. signoreti*," records of which have very probably included not only *A. mormon*, *A. occidentalis*, and *A. arizonus*, but possibly also *A. lunatus*, stands in our lists as from "Arizona, California, Colorado and New Mexico."

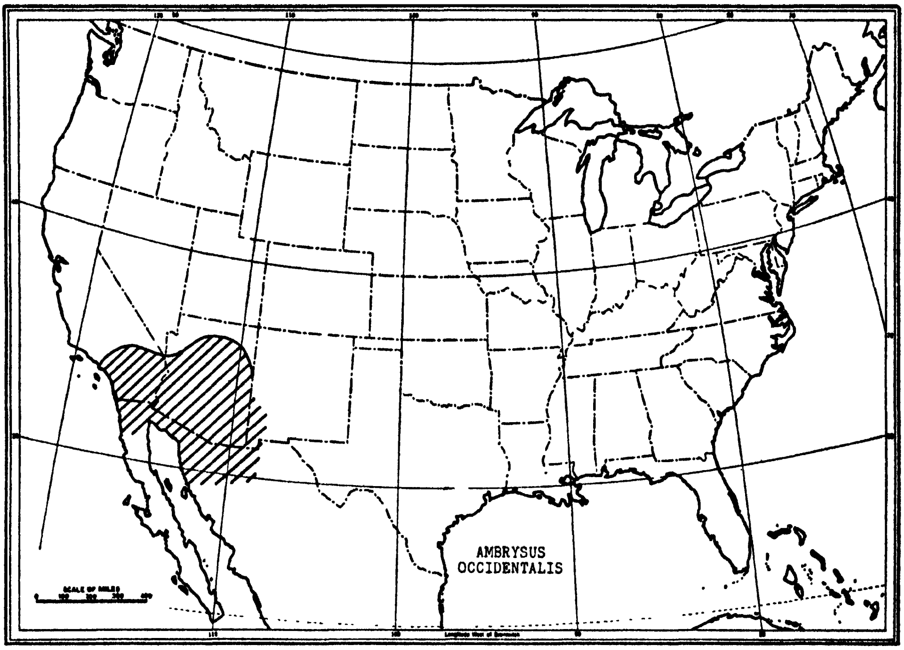

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Fig. 11. Distribution of *Ambrysus occidentalis*.

Material examined (see fig. 11).—ARIZONA: Type locality—Cochise Co., San Bernardino Ranch, 3,750 ft. elev., August, F. H. Snow (UK); Coconino Co., Bill Williams Fork, August, F. H. Snow (UK); Pima Co., Catalina Mountains, 23(x)41, V. Potter; 3(viii)30, L. K. Gloyd (UM); Santa Cruz Co., Patagonia, 7(ix)38, C. L. Hubbs and family (UM); Yavapai Co., Camp Verde, 2(ix)38, C. L. Hubbs and family (UM); Fort Whipple, Horn (USNM). CALIFORNIA: Orange Co., San Juan Capistrano Creek, near San Juan Capistrano, 1(i)39, R. G. Miller (UM); Riverside Co., Indio, 24(vii)29, L. D. Anderson (UK); San Bernardino Co., Mojave River in Afton Canyon, 38 mi. E of Barstow, 26(vii)40, R. R. and R. G. Miller (UM); San Diego Co., Dulzura, 9(viii)35, J. Beamer; Miramar, 28(vii)38, R. I. Sailer (UK). MEXICO. BAJA CALIFORNIA: Ensenada, 11(iv)40, R. G. Miller (UM); SONORA: Palmer dist., Alamos, 27(x)34, H. S. Gentry (UK). All the material listed is paratypic.

Interestingly enough, the Camp Verde locality in Arizona has yielded *A. mormon*, *A. occidentalis*, *A. arizonus*, and *A. puncticollis*, but whether they occur together or in different ecologic situations is unknown to me.

Ambrysus lunatus Usinger

(Pl. 4, *m; fig.* 13, *m*)

Ambrysus lunatus Usinger, 1946, Bull. Univ. Kans., Sci. Bull., 31 (1): 203.

General appearance.—A strongly variable species, both in size and color; rather more than medium in size, 8.5–11.5 mm. long, 6–8 mm. wide. Dorsum strongly and contrastingly mottled with yellow and brown, moderately shiny, generally not conspicuously lighter anteriorly. Venter light yellow or greenish to amber, without dark markings, generally lighter posteriorly.

Head.—Ground color whitish yellow to amber (often with a greenish tinge), with a variable development of deep-brown streaking; when best developed, this streaking takes the form of a prominent central longitudinal stripe, generally quite obviously composed of two series of brown dots superimposed on a brown background, or even, in extreme cases, of two separate brown streaks, enlarging posteriorly and either terminating in a bilobed brown spot at base of head or ending just short of such a spot; occasionally two lateral, subsidiary streaks develop, particularly anteriorly, where they fuse with the main central markings; this pattern may be greenish and in faded specimens may be almost completely obliterated. Surface shiny, glistening in clean specimens, micropunctate and minutely but smoothly roughened in some individuals. When oriented so that the dorsal plane is perpendicular to line of vision (i.e., the greatest amount of dorsum exposed to view), front of head is seen to be slightly protuberant before eyes, either smoothly rounded, or with a faint suggestion of truncation. Eyes blackish, outer and inner margins slightly curved, posterior margin strongly curved; viewed posteriorly, eyes practically flush with head surface, any protuberance entirely negligible. Head moderately and widely set into anterior pronotal border. Labrum same color as front of head; ratio of length to width, 21: : 43 (49 per cent); mouthparts darkening at tip. Head ratios are:

1) Total length to width (including eyes), 74: : 117 (63 per cent).
2) Anterior distance between eyes to posterior distance, 60: : 71 (85 per cent).
3) Posterior distance between eyes to greatest length of head posterior to this line, 71: : 21 (30 per cent).

Pronotum.—Shiny, smooth, conspicuously but minutely punctate, prominent transverse rugulosities developing centrally behind region of deepest head penetration. Ground color golden yellow to light yellowish green with a variable development of brown mottling and dotting on disc; the best-developed pattern consists of three irregular dark-brown longitudinal streaks occupying each side of the disc, the outermost one a vaguely outlined suffusion, succeeded closely by an equally vague, semilunate aggregation of brown dots, which is followed, after a considerable gap, by another rather vague aggregation of brown dots adjacent to the median line—the anterior portion of this last is composed of the rich, subdermal brownish suffusion which, in most species with this general color pattern, forms an isolated unit of the characteristic pair of such large spots occupying an otherwise clear V-shaped area directly behind area of deepest head penetration—the remainder of this median aggregation is composed of dots which widen out considerably, somewhat triangulately against the posterior pronotal line which forms its base; the pattern described is subject to much reduction, and in some rather opaque specimens, all semblance of dotting disappears and is replaced by suffusions. Thin, transverse, posterior pronotal line forms the base of the varicolored disc and is generally quite distinct; it is always interrupted medially and separates the disc from the uniformly light-yellow or yellow-green, broad, posterior pronotal margin, which may be set with numerous, microscopic black points. Lateral edges smooth, unserrate, occasionally with weakly discernible marginal pilosity; when head is firmly seated in anterior pronotal border, outer edge of pronotum and eye forms essentially a more or less smooth contour, i.e., the emargination caused by the junctures is insignificant. Lateral pronotal curvature, expressed in terms of straight-line distance between anterior and posterior lateral angles and greatest vertical distance between this baseline and line of curvature, is 13 per cent (62: : 8). Posterolateral angles well rounded. Venter lacking any dark areas, generally golden yellow, often with a pronounced greenish cast laterally; well furred along posterior margin and on keel. Dorsal pronotal ratios are:

1) Width between anterior angles to width between posterior angles, 62: : 120 (52 per cent).
2) Median length to greatest width, 41: : 120 (34 per cent).

3) Width between anterior angles to distance between anterior angle and posterior baseline of pronotum, 62 : : 58 (94 per cent).

Scutellum.—Conspicuously light-and-dark banded (neither color predominating) with light yellow and light to dark brown, often with a pronounced greenish tinge; in general, the pattern is one of two distinct, wide, dark, longitudinal bands occupying centrum of scutellum and separated by a prominent yellow, narrower line; the lateral scutellar sides are generally entirely yellow. Shiny but not polished, shagreened with dense, shallow punctation, each puncture the seat of a white spot. In normal position, i.e., approximately on a plane surface with remainder of body, ratio of three sides, anterior and two laterals, is 74 : : 54 : : 53.

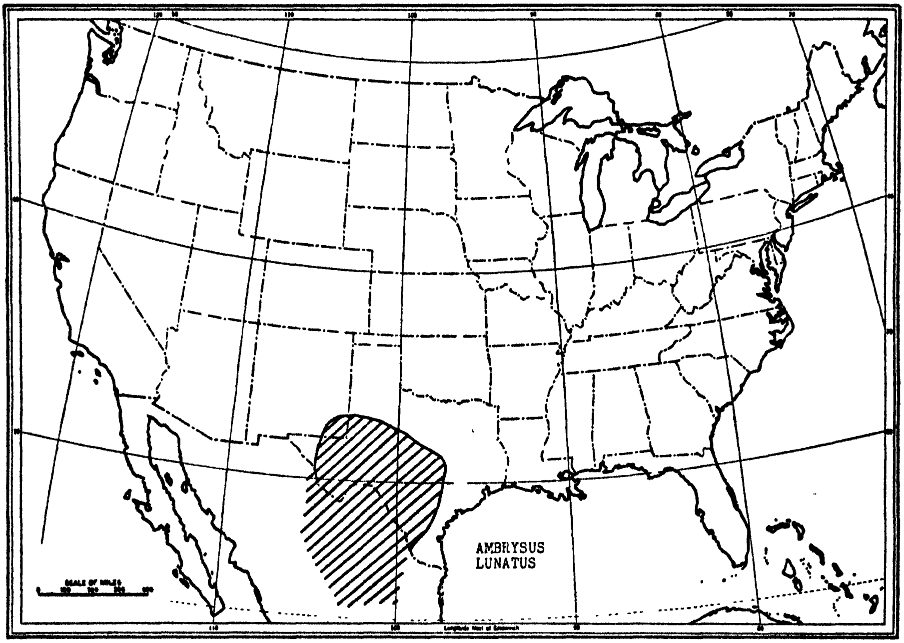
Hemelytra.—Strongly and contrastingly mottled with brown and yellow or green; when best developed, the pattern of light areas consists of a large light area on embolium, an elongate light spot at posterointernal corner of embolium, a long light, narrow spot originating just posterior to the last-named spot and fusing with a long light streak which borders the entire inner edge of each wing from posterior scutellar angle nearly to caudal end of corium-membrane juncture; occasionally a weak, small light spot develops at wing margin just posterior to embolium, and a vague lightening of membrane centrum may also be evident. Such a pattern may suffer considerable reduction and obliteration but is recognizable in all specimens studied. Surface shiny but not polished, shagreened as is scutellum. Embolium rather wide and short for the genus, (length to width, 132 : : 46 = 35 per cent), with sparse, inconspicuous marginal pilosity in unrubbed specimens; color proportions somewhat variable, the light anterior portion varying from only slightly more than half the emboliar area to fully two-thirds—posterior part brownish. Hemelytra very strongly exposing lateral connexival margins, which are varying shades of yellow or green, with dark spots at connexival junctures and with definite marginal pilosity. Posterolateral connexival angles conspicuously and moderately strongly spinose. Hemelytra just, or not quite, attaining abdominal tip.

Venter.—The prothoracic venter has been discussed above. Remainder of venter lacking any conspicuous dark areas, lighter posteriorly owing to the dense, short, golden hydrofuge pelt covering abdomen and usually lacking from mesosternum and metasternum; general ventral color varies from deep yellow to light yellowish or yellow green, the legs sometimes contrastingly green against a yellowish body background; emboliar venter unicolorous to distinctly longitudinally bicolored, lighter exteriorly, darker interiorly. Connexival posterolateral angles markedly spinose except those of segment I, which is, at most, but slightly right-angulate produced; connexival margins distinctly but very minutely serrate on posterior segments, smooth anteriorly; connexival borders more or less subparallel for most of their lengths, then dip inward rather abruptly under shadow of spines of adjacent segments; spines generally distinctly and contrastingly darker than remainder of connexival border. Female subgenital plate unequally quadriangulate at apex, the "angles" well rounded, broad, low; the two central ones more prominent ventrally and caudally than the lesser, "shoulder" angles. Male genital hook strongly curved to the left, short, platelike, quite distinctly boot-shaped.

Legs.—Prolegs: Coxa elongate, somewhat angularly globular, amber to greenish, smooth, flattened to receive heel of femur, distal edges darker. Trochanter well developed, smooth, shiny, same color as coxa, with a tuft of yellowish hairs distally on anterior end. Femur smooth, yellow or green, polished, widest near proximal end, narrowing rapidly to distal end (i.e., characteristically incrassate), compressed dorsoventrally, with typical short, very dense mat of hairs along front border which serves as a resting groove for tibia when closed against femur; ratio of length to greatest width of ventral surface is 95 : : 61 (64 per cent). Tibia long, slender, smooth, same color as femur but usually slightly darker, darkening apically, curved most strongly in distal part where, with the single tarsal segment, it forms a continuous, curved, grasping instrument—combined tibia-tarsus, when closed, generally slightly, but definitely, exceeding adjacent (proximal) end of femur. Tarsus darkening at tip.

Mesolegs. Coxa long, amber to light yellowish green, somewhat angularly globular, equipped with short, dense, yellow pile, slightly curved from posterior end weakly to anterior end, the outer face flat for reception of basal part of femur. Trochanter large, same color as coxa, smooth distally, pilose proximally. Femur long, narrow, smooth, shiny, golden yellow to green, compressed dorsoventrally, weak and sparse setulosity on proximal half of outer or anterior edge;

a row of short, reddish chitinous points on dorsointernal (dorsoposterior) margin and short, dense, anteriorly weak pilosity on ventrointernal (ventroposterior) margin; ratio of length to median width of ventral surface is 96: : 18 (19 per cent); length, 2.45 mm. Tibia deep yellow to green, smooth, shiny, long, narrow, bristling with reddish spines arranged in four longitudinal rows representing the four very weak "corners" of tibia; ventrointernal (ventroposterior) row of spines consisting of single spines alternating with very short, transverse rows of smaller spines; dorsal face proximally clothed with a mat of long, yellow hairs; distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row incomplete on outer or anterior edge, about half the length of complete, terminal row; ratio of length to median width of ventral surface is 82: : 10 (12 per cent); length, 2.25 mm. Tarsus smooth, long, narrow, same color as tibia, pilose and setose ventrally; terminating in two slender, yellowish to greenish claws, darkening at tips and moderately curved.



Base map copyrighted by Standard Process and Engraving Co , Berkeley, California

Fig. 12. Distribution of *Ambrysus lunatus.*

Metalegs: Coxa swollen, globular, golden yellow to light yellowish green, well furred with short, dense, yellow pile, flattened ventrolaterally for reception of basal part of femur. Trochanter well developed, same color as coxa, pilose proximally, smooth and shiny distally. Femur long, narrow, smooth, golden yellow to greenish, dorsoventrally compressed; sparse, short, reddish spination on outer (anterior) margin; inner (posterior) margin with a row of reddish chitinous points dorsally, and short, dense pilosity (which may be rubbed) ventrally; markedly long pilosity on posterodorsal edge; ratio of length to median width is 133: : 22 (16 per cent); length, 3.20 mm. Tibia long, narrow, shiny, same color as femur but often with a greenish tinge, armed with four rows of reddish spines, the rows more or less equally spaced about tibial circumference; a mat of dense, long, deep-yellow hairs occupying inner (posterior) face—distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row incomplete, only about half length of complete, terminal row; ratio of length to median width of ventral surface is 148: : 13 (9 per cent); length, 3.90 mm. Tarsus smooth, long, same color as tibia; spinose and pilose ventrally, terminating in two yellowish, moderately curved claws, darkening at tips.

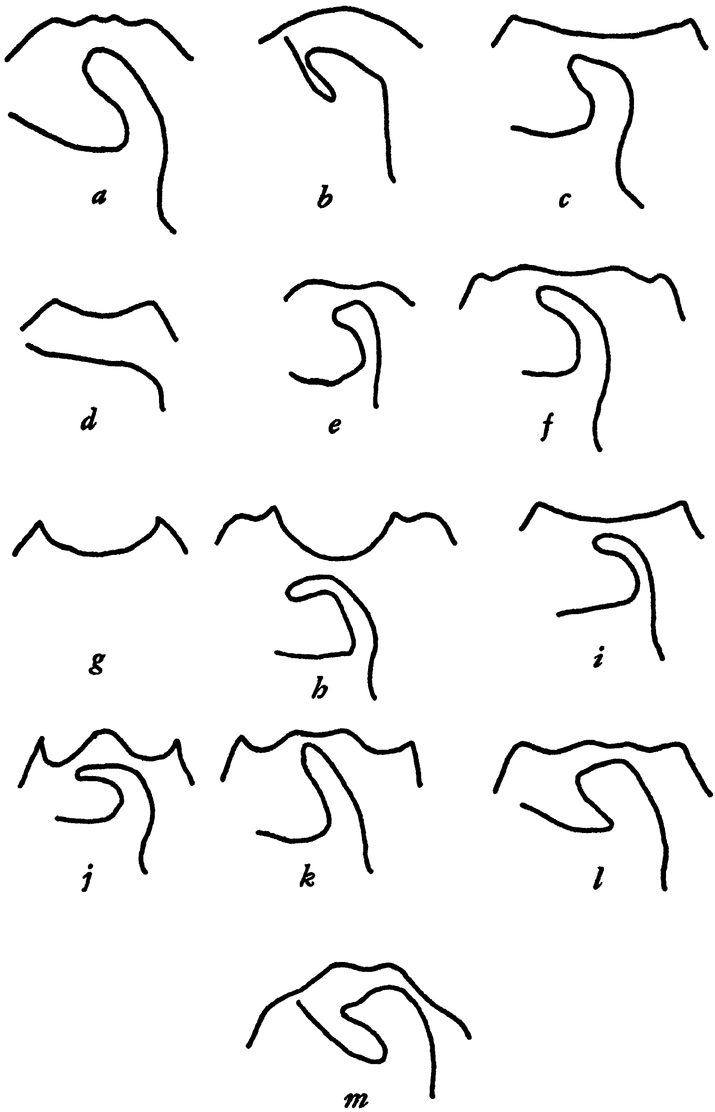


Fig. 13. Top outline of each pair represents the caudal tip of the female subgenital plate, the outline beneath it the corresponding male genital process. The former occupies the ventral tip of the abdomen; for studying it no preparation of the animal is necessary, except that occasionally obscuring pilosity must be removed for examination of the plate. The male genital process is dorsal in position; the entire abdominal tip must be removed before the structure can be studied. In dried material, only moderate pressure on the dorsum of the tip causes the stalked tip to break, the tip is then mounted on a point below the insect. In figure 13, *g* the male structure is not shown, because the only known male (holotype) was not available for dissection.

a. Ambrysus circumcinctus.
b. Ambrysus melanopterus.
c. Ambrysus puncticollis.
d. Ambrysus funebris.
e. Ambrysus pulchellus.
f. Ambrysus californicus.
g. Ambrysus buenoi.
h. Ambrysus mormon mormon.
i. Ambrysus mormon heidemanni.
j. Ambrysus woodburyi
k. Ambrysus arizonus.
l. Ambrysus occidentalis.
m. Ambrysus lunatus.

Type locality.—"Tom Greene County, Texas, July 15, 1928, R. H. Beamer collector."

Location of types.—"Holotype, male, and allotype, female (Snow Museum, University of Kansas)."

Recorded distribution.—Texas.

Material examined (see fig. 12).—MEXICO. PUEBLA: Puebla, 19(vii)37, H. D. Thomas (UK). UNITED STATES. NEW MEXICO: Eddy Co., 12(vii)27, R. H. Beamer (UK). TEXAS: Kerr Co., 9(iv)39, D. Millspaugh (UK); Menard Co., 19(vii)28, R. H. Beamer (UK); Tom Greene Co., 15(vii)28, R. H. Beamer (UK); Travis Co., 10(iv)39, D. Millspaugh (UK); Val Verde Co., Del Rio, 8(vii)38, D. W. Craik–R. I. Sailer (UK).

United States records of *A. pudicus* from "Wyoming, California," are certainly based on small examples of *A. mormon* (of the *A. m. heidemanni* type) for the former locality, and on *A. californicus* in California. *A. woodburyi* is also suspect here, being a small obscure type which could readily be labeled "*A. pudicus*" in the general confusion which has surrounded the use of the latter name for the United States.

A. guttatipennis and *A. signoreti* are Mexican species; the many uncertainties still surrounding them will begin to unravel only when much more material is available for study. Records of *A. guttatipennis* for "Arizona" could have been based on either *A. arizonus* or *A. occidentalis*, and, as was pointed out under *A. occidentalis*, the records for "*A. signoreti*" probably resulted from the confusion of several species. Very probably, the terms "*A. guttatipennis*" and "*A. signoreti*" have been simultaneously used by different people for the same material, since few aquatic bugs have led a more confused existence in the literature of the western United States.

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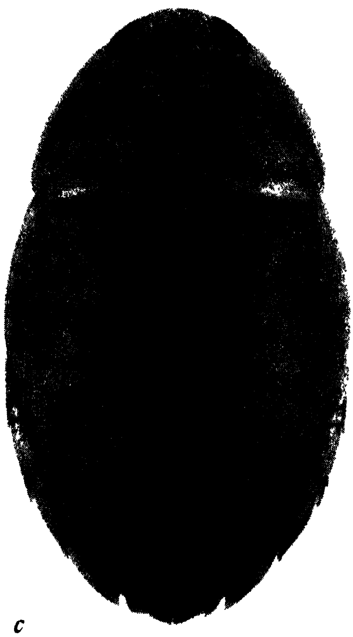
PLATES

a

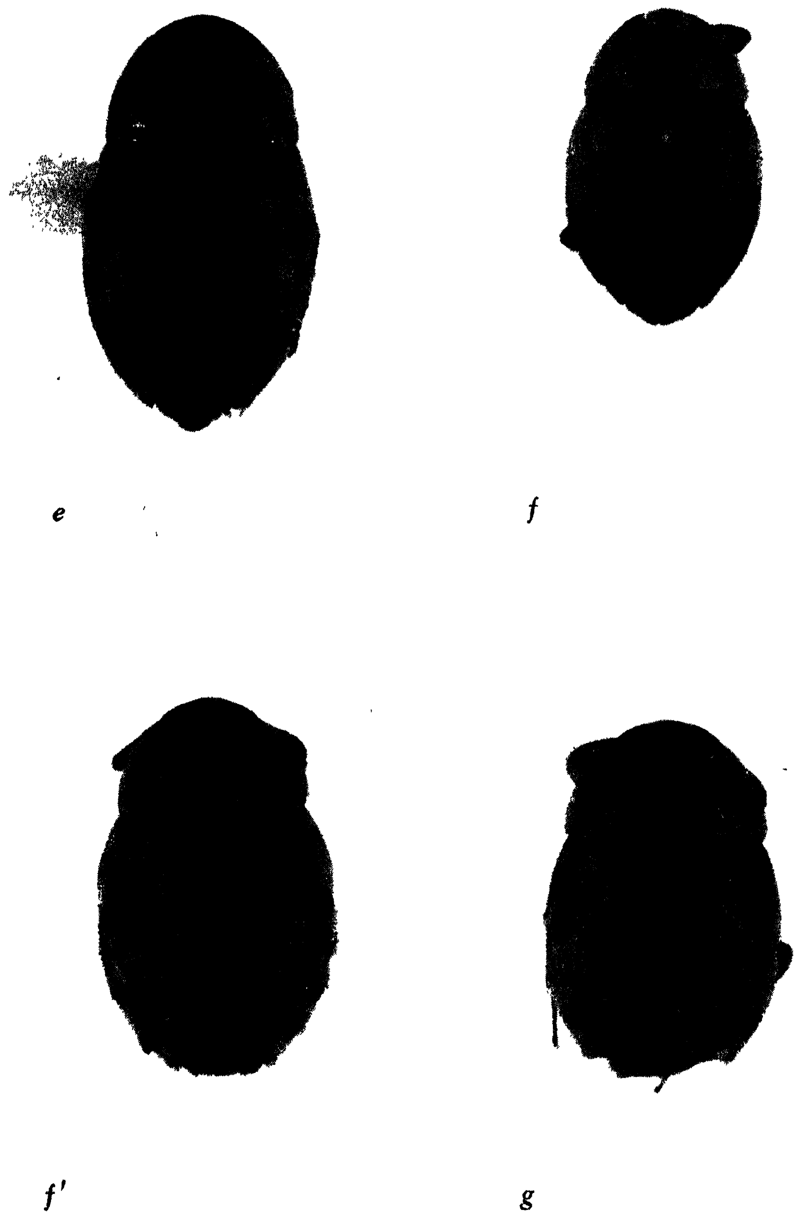
b



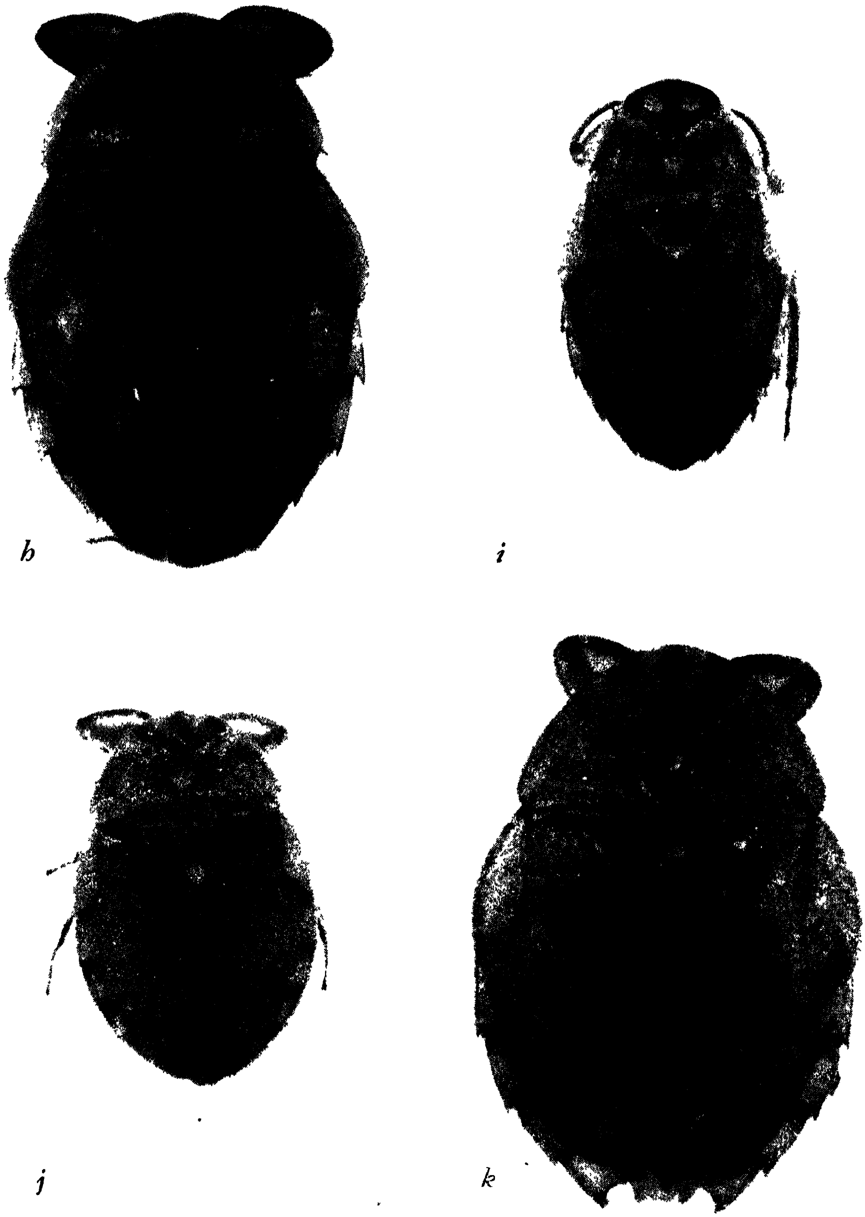
c

d

a. *Ambrysus circumcinctus*, × 6.
b. *Ambrysus melanopterus*, × 6.
c. *Ambrysus puncticollis*, × 6.
d. *Ambrysus funebris*, × 6.



e. Ambrysus pulchellus, × 6.
f. Ambrysus californicus californicus, × 6.
f'. Ambrysus californicus bohartorum, × 6.
g. Ambrysus buenoi, × 6.



h. Ambrysus mormon mormon, × 6.
i. Ambrysus mormon heidemanni, × 6.
j. Ambrysus woodburyi, × 6.
k. Ambrysus arizonus, × 6.


l


m

l. Ambrysus occidentalis, × 6.
m. Ambrysus lunatus, × 6.

A GENERIC REVISION OF THE FAMILY AGROMYZIDAE (DIPTERA) WITH A CATALOGUE OF NEW WORLD SPECIES

BY

KENNETH E. FRICK

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CONTENTS

A GENERIC REVISION OF THE FAMILY AGROMYZIDAE (DIPTERA) WITH A CATALOGUE OF NEW WORLD SPECIES

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INTRODUCTION

A REVISION of the family Agromyzidae has long been needed for the North American species. Since heterogeneous groups of species have been included in the genera *Agromyza* s.l. and *Phytomyza* s.l., a generic revision is particularly needed. This paper is based on a study of the types of most of the proposed agromyzid genera and a large number of other North American and European species. All but five of the European genera contain species that occur in our fauna, and these genera are accepted without reservations. The valid genera are here recharacterized.

A catalogue of New World species is included so that the nomenclature of the agromyzids of the Western Hemisphere is brought up to date. New combinations are necessary for many of the species, and new names are necessary for some. A few species from the Western Hemisphere have not been positively placed, but these are included in supplementary generic lists.

Melander (1913) published a synopsis of North American species of agromyzids in which he applied the names of many species originally described from Europe. His European material, obtained from Strobl, has subsequently been shown by Hendel to have contained many misidentifications. Malloch, working independently of Melander, revised the genera *Agromyza* and *Cerodontha* in a paper that was published a few weeks after Melander's paper. Malloch's paper contained synonyms of some of Melander's species, but some of the synonymy has never appeared in the literature.

In 1920, Hendel published a *Prodromus* in which he greatly revised the generic concepts for the Palearctic region. At that time he pointed out the need for further study of the North American species, taking into consideration new divisions which split up the very large genera, *Agromyza* and *Phytomyza*.

Hendel (1927) modified his concepts, aided by the larval studies of de Meijere (1925, 1926) and the biological studies of Hering (1926*b*, 1927*a*). By 1931, when Hendel published the first part of a monograph of the Palearctic species, he had more thoroughly characterized generic limits. The monograph, which was completed in 1936, forms the basis for all subsequent European work within the family.

Frost (1924) primarily followed Malloch's earlier treatment of *Agromyza* and Melander's earlier treatment of *Phytomyza* in reviewing the North American species. Nothing has been published since 1924 regarding North American agromyzids, with the exception of descriptions of new species referred to heterogeneous groups maintained in *Agromyza* and *Phytomyza*.

ACKNOWLEDGMENTS

This study would not have been possible but for the generous assistance of a number of persons to whom I wish to extend special thanks and to express my deep appreciation. Through the kindness of Dr. E. M. Hering of the Zoologisches Museum in Berlin, numerous specimens were made available; the large number of type species were particularly valuable. I am deeply grateful for the loan of the only specimens in the Zoologisches Museum collection of the types of the genera *Liriomyza, Metopomyza,* and *Gymnophytomyza.* A large number of identified mined leaves were included from Dr. Hering's herbarium. Dr. A. L. Melander extended the privilege of studying his valuable collection, including the types. Dr. Melander's microscope and manuscript notes were placed at my disposal, and he and Mrs. Melander graciously opened their home to my wife during our pleasant visit. Mr. C. W. Sabrosky of the U. S. National Museum freely lent material requested, drawing upon his personal collection when necessary. Because of his coöperation I was able to determine the correct generic placing of certain North American species. The entire agromyzid collection of the California Academy of Sciences was lent to me through the courtesy of the curators, Drs. E. S. Ross and E. L. Kessel. The collection was particularly rich in eastern North American species collected by the late E. P. van Duzee. Dr. P. D. Hurd, curator of the University of California collection, gladly allowed me to borrow all the agromyzids. Although not rich in species, the material was valuable because of the early records of economic species collected by Professor E. O. Essig. Dr. H. H. Ross kindly lent three paratypes of *Limnoagromyza dianthereae* Malloch from the Illinois Natural History Survey collection.

Dr. A. E. Pritchard carefully read the preliminary drafts of this paper and offered advice, encouragement, and valuable assistance throughout the study. Professor E. O. Essig made available the facilities of the University of California and gave continued encouragement. Dr. H. E. Thomas took great interest in the work and reviewed the manuscript, and Dr. P. A. Ark graciously translated parts of Braschikov's paper from the Russian. My wife accompanied me on the collecting trips and through her patience and encouragement assisted me throughout the study. Her typing of the various drafts and of the final paper helped materially.

DISTRIBUTION

The family Agromyzidae is world-wide in distribution. Flies belonging to it have been found on every continent. Such islands as the Seychelles, New Zealand, Samoa, the Galápagos, Greenland, Formosa, the Azores, and the West Indian chain (including Bermuda) harbor species which often are found on the adjacent continents; but the islands are not known to support endemic genera.

Although adults have been found in Baltic amber from the lower Oligocene (Meunier, 1905), and in Eocene deposits (Cockerell, 1924) and lower Miocene deposits (Heer, 1850), and mines have been found in the Miocene (Hering, 1930) and Oligocene (Göppert, 1855), the family is apparently of fairly recent origin. This opinion is expressed because the family contains a large number of very closely related and only slightly differentiated species, grouped into a few large genera with most of which small or monotypic genera are closely associated. The

homogeneity of the family throughout its distribution, even in situations of apparent isolation over a rather long period, further supports the recent-origin theory.

The agromyzid flies are without doubt spread by man. The presence of *Melanagromyza simplex* (Loew) wherever asparagus is grown would seem to confirm this. One species, *Ophiomyia lantanae* (Froggatt), has been deliberately distributed by man. The larvae of this species mine the seeds of lantana in Mexico. Because lantana had become a pest in Hawaii, Samoa, Australia, Burma, and elsewhere, this fly was introduced to aid in its control.

Figures giving comparative numbers of species on the various continents are not available, but Hendel (1931*a*) lists some estimates based on the literature up to that date. According to him, there are about 350 species in the Palearctic region, 120 in the Nearctic region, 30 in the Neotropical region, 40 in the East Asian islands (including Formosa), 23 in Australia and New Zeland, and only 2 in the Ethiopian region. The picture of distribution shown by these figures is distorted, because of the dearth of knowledge about these small flies in uncivilized regions of the world. As an example, de Meijere (1940), in reporting on a collection of agromyzids made in the Cameroons, found 43 species, of which only 2 are found in the Palearctic region.

Hendel (1931*a*) believed that the genus *Phytomyza,* the most specialized large genus of the family, originated in Europe. This theory is based on the fact that about half the species of agromyzids in Europe belong to this genus, whereas only one-fourth of the agromyzids in North America belong to the genus *Phytomyza.* In South America there are only a few species of *Phytomyza* as compared with the numbers of species in other genera.

ECONOMIC IMPORTANCE

In spite of the large number of species in the family, comparatively few can be considered of economic importance. Even those attacking agricultural crops seldom permanently or severely injure the host plants. The mines are small and do not kill the leaves unless the leaf is so small that the mine covers nearly all of it or there are a number of mines in one leaf. The attacked plants, if healthy and vigorous, will often outgrow leaf-mining damage.

Hymenopterous parasites are important factors in holding most infestations to a moderate level. However, the parasites usually do not find a larva until its mine is one-fourth to three-fourths completed, and there are always a few mines that escape detection by the parasites. Even in instances of high parasitism, many mines can be found.

Parasites, therefore, cannot be relied upon to give control when mine-free leaves are desired for commercial purposes. This is very important in the cut-flower and nursery industries, because mines of the larvae mar the appearance of the foliage, reducing market value. When the damage is extensive, the producers are sometimes unable to sell the flowers or the foliage. Numerous studies have been conducted to perfect controls of leaf miners on ornamental plants: the control of *Liriomyza langei* Frick in aster leaves (Jefferson and Pence, 1948); the control of *Phytomyza ilicis* Curtis on *Ilex aquifolia* (Downes, 1931, 1948; Downes and Andison, 1941); and the control of *Phytomyza ilicicola* Loew on *Ilex opaca* (Felt and Bromley, 1938; Hartzell, 1943; Hartzell, Collins, and Blauvelt, 1943; Underhill, 1943).

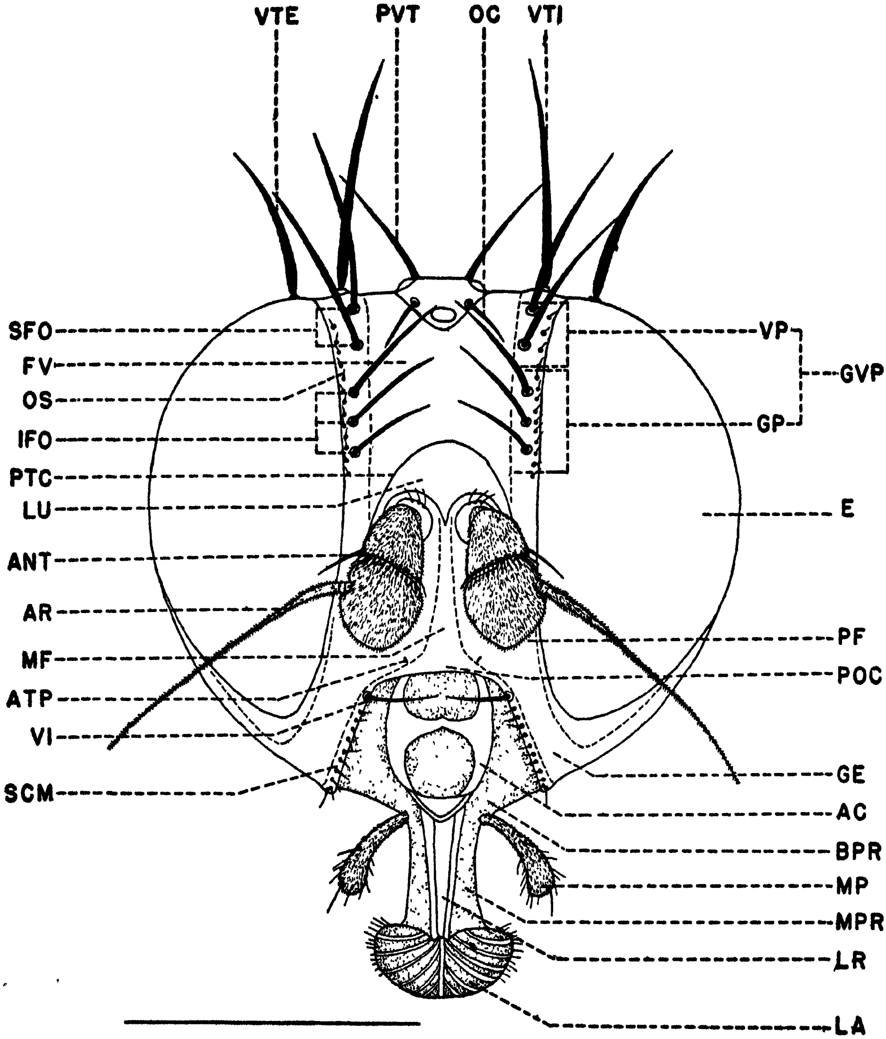


Fig. 1. Front view of head of *Agromyza reptans* Fallén. The solid line represents 0.5 mm.

Sclerites, areas, and sutures

Fv	frontal vitta	Ge	genal area
E	compound eye	Scm	subcranial margin
Gvp	genovertical plate	Ac	anteclypeus
Gp	genal plate	Bpr	basiproboscis
Vp	vertical plate	Mp	maxillary palpus
Pf	parafacial region	Mpr	mediproboscis
Lu	lunule	Lr	labrum
Ptc	ptilinal fissure	La	labella
Mf	mesofacial plate	Ant	antenna
Poc	postclypeus or epistoma	Ar	arista
Atp	anterior tentorial pit		

Setae

vte	outer vertical
vti	inner vertical
pvt	postvertical
oc	ocellar
sfo	upper fronto-orbital
ifo	lower fronto-orbital
vi	vibrissa
os	orbital setulae

In the San Joaquin Valley, California, *Liriomyza* sp. attacks alfalfa, beans, cotton, melons, and tomatoes, as well as weeds and herbs along margins of the fields. During July and August, 1948, the population of this fly was very large, and severe injury was caused to melons and tomatoes. Because many leaves were killed, the third crop of melons was exposed to the sun, and this may have reduced the flavor of the fruit. Michelbacher *et al.* (1949), however, observed that the defoliation of most tomato plants occurred so late that little damage was done.

Wolfenbarger (1947) reports *Liriomyza* sp. as causing damage to a number of crops in Florida, including bean, pea, cabbage, turnip, okra, squash, tomato, and potato. Although parasites and predators are reported to keep this species usually under control, sporadic outbreaks are sometimes severely destructive.

The pea-leaf miner, *Liriomyza langei* Frick, at times becomes very abundant in the Santa Clara Valley, California, on garden peas (Lange and Smith, 1947). The damage caused by the larvae does not appear to reduce the yield, but the mines make the pods less pleasing to the eye and hence lessen the market value of the peas. The fly also regularly attacks such crops as spinach and lettuce, mining the edible parts of the leaves. Heavy infestations were seen in the summer of 1948 on spinach leaves in California grocery stores.

At least one agromyzid, *Melanagromyza phaseoli* (Coquillett), has throughout its distribution proved to be sufficiently destructive to require yearly control measures. This species, the bean fly, was first reported in New South Wales as a pest of French beans, *Phaseolus vulgaris,* by Froggatt and McIntyre (1898). The larvae mine the stems of young bean and other leguminous plants at ground level, causing the plants to wither and die. Losses vary from 50 to 100 per cent of the plants. If the infestation is not severe—i.e., if there are fewer than eight or ten larvae to a stem—banking the soil around the stems to hasten the growth of the adventitious roots frequently results in nearly normal production. *M. phaseoli* is widespread in the tropics and the Southern Hemisphere, and numerous papers have been written on its control (van der Goot, 1930; Morgan, 1938; Wallace, 1939; Hely, 1947; Hassan, 1947).

Fink (1913) considered that the asparagus miner, *Melanagromyza simplex* (Loew), caused serious damage to asparagus. Subsequent studies (Barnes, 1937; Eichmann, 1943*a*) have shown that the injury to the stems is actually superficial when there are no secondary invaders. Eichmann (1943*b*) did not recommend control measures for this insect in the asparagus-producing regions of Washington. My unpublished studies on this insect in the Yakima Valley, Washington, confirm the contention that the asparagus miner is not a serious pest.

MORPHOLOGY

Adult

HEAD

(Fig. 1)

The terminology used by Crampton (1942) is accepted, as are his interpretations of the various sclerites and regions, with the exception described below.

Hendel (1928) designated as "schizometopous" those flies in which the membranous frontal vitta (Fv) is separated on each side from the compound eyes (E) by the continuous genovertical plates (Gvp). These plates continue ventrally,

merging uninterruptedly into the parafacial plates (Pf). The species in the family Tephritidae have each genovertical plate visibly divided by a transverse suture which does not extend upon the frontal vitta. This division is obscured in the family Agromyzidae, but the character of the setae indicates that each genovertical plate is probably composed of two united plates. The anterior or ventral portion (*Wangenplatte* = genal plate) (Gp), which merges directly with the parafacial region (Pf), bears the inward-directed, lower fronto-orbital setae (ifo). These vary in number from one to seven and are usually placed with their bases slightly nearer to the compound eye than are the bases of the setae immediately dorsad of them. The posterior or dorsal portion (*Scheitelplatte* = vertical plate) (Vp) bears one to three upward- or outward-directed, upper fronto-orbital setae (sfo).

The remaining head areas include the lunule (Lu), which is terminated posteriorly by the arched ptilinal fissure (Ptc), and the parafacial region (Pf), which is an indefinite area extending from the vibrissa dorsally to about the lowest fronto-orbital seta. Laterally, the parafacial region includes the area from the ptilinal fissure to the eye. The mesofacial plate (Mf) has a central carina. This carina is usually not prominent, and it is rarely completely absent or enlarged. The mesofacial plate is delimited ventrally by the postclypeus or epistoma (Poc). The line of division is based upon the position of the anterior tentorial pits (Atp) which are not visible externally. The genal area (Ge) (*Backen*) is the same as that often designated as the cheeks and refers to the region ventrad of and also slightly posterior to the compound eyes. The area immediately ventrad of each eye, delimited ventrally by the broken line, has been termed the bucca (*Wangen*) by many workers. Since this area is of little taxonomic value, in this paper it is considered as a part of the genal area. The subcranial margin (Scm) is used to designate the border of the cavity containing the mouthparts.

The mouthparts, shown semidiagrammatically, consist of the sclerotized anteclypeus (Ac); the membranous basiproboscis (Bpr), which bears the maxillary palpi (Mp); the mediproboscis (Mpr) with the labrum (Lr) lying dorsally along it, while ventrad is the sclerotized prementum (not shown); and the labella (La) with typical pseudotracheae. The mediproboscis and labella may be greatly elongated; if so, the labella is doubled back under the mediproboscis when in repose. The subcranial margin is somewhat drawn out ventrally when the mouthparts are elongate.

Minute setae, here termed orbital setulae (os), are usually present throughout most of the length of each genovertical plate between the margin of the compound eye and the row of fronto-orbital setae. These setulae are not visible under low magnifications, the largest of them being discernible at twenty-seven power. The orbital setulae may be anteriorly directed, erect, or dorsally directed; the direction is of primary importance in generic classification.

The other major setae present on the agromyzid head are the inner vertical setae (vti); the outer vertical setae (vte); the postvertical setae (pvt), which are always strongly divergent (absent in *Xeniomyza*); the ocellar setae (oc); and the vibrissae (vi).

THORAX

Crampton's terminology is used for the thoracic regions and the sclerites. The chaetotaxy of Walton (1909) is employed with minor exceptions. The following

letters are used to designate the various setal groups: humeral (h); presutural (prs); supra-alar (sa); intra-alar (ia); postalar (pa); dorsocentral (dc), given according to the number after and before the transverse suture, as 3 + 1, the posteriormost pair being the first pair; acrostichal (acr); scutellar (sc); propleural or prothoracic (pp); anepisternal (aes); katepisternal (kes).

WING

(Fig. 2)

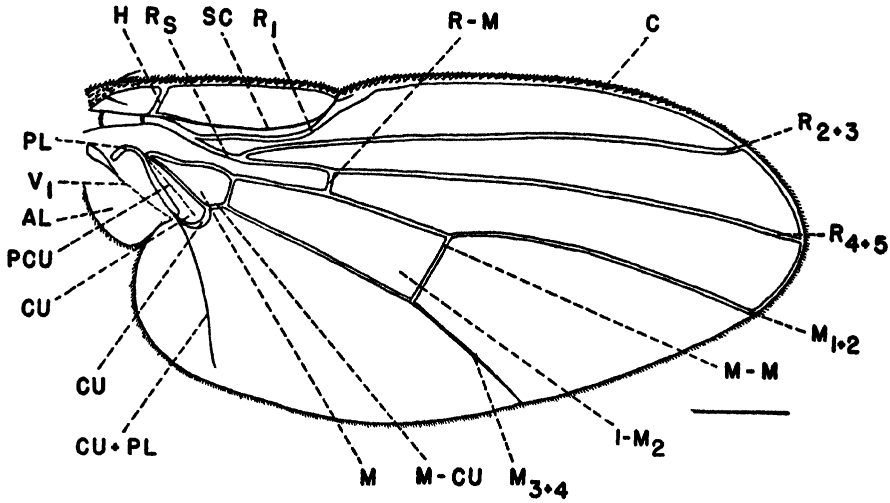


Fig. 2. Wing of *Agromyza reptans* Fallén. The solid line represents 0.5 mm.

Veins

C	costal
H	humeral
Sc	subcostal
R_s	radial sector
R_1	first longitudinal
R_{2+3}	second longitudinal
R_{4+5}	third longitudinal
M_{1+2}	fourth longitudinal
M_{3+4}	fifth longitudinal
Cu	cubital
Pl	plical
Cu + Pl	cubital plus plical
Pcu	postcubital
V_1	first vannal

Crossveins

r-m	radiomedial or anterior
m-m	medial or posterior
m-cu	mediocubital

Cells

$1\text{-}M_2$	discal
M	medial or second basal
Cu	cubital
Al	axillary lobe or alula

The Comstock-Needham system of venation as modified by Tillyard is employed with slight modifications. The radial sector is considered as comprising veins R_{2+3} and R_{4+5}. Alexander (1927) and Hendel (1928) interpret R_1 as being combined with R_2; and R_s, therefore, as being comprised of R_{3+4} and R_5. The evidence is here considered insufficient to establish this interpretation for the higher Diptera.

Hendel used the terms Cu_1 and Cu_2 in referring to the cubital area. The Cu_2 of Hendel is interpreted as being the postcubitus (Pcu), a concave fold that is not intimately associated with the flexor sclerite. Nor does the postcubitus seem to be associated with the base of M or Cu. This short fold is terminated by the pos-

teriorly and basally curving Cu. The cubital vein (Cu) has not been given a branch designation, because there is doubt as to its correct interpretation.

The basal section of the first vannal, which equals the plical (Pl) of Bradley, is associated with the third (flexor) sclerite, a criterion of this vein. It joins Cu and approaches the wing margin, where it is termed Cu + Pl rather than the anal vein. The enclosed cell is termed the cubital cell (Cu) rather than the anal cell.

The posterior cross vein (Tp of Hendel) is termed the medial cross vein (m-m), because it connects M_{1+2} and M_{3+4}. This cross vein may be absent or it may migrate toward the base of the wing. In the genus *Pseudonapomyza*, m-m has migrated so far basally that it appears to displace the transverse portion of M_{3+4}.

Both the axillary lobe (alula) (Al) and the distal calypter (attached to the wing) are usually developed, though the latter is small; both are rarely absent. The proximal calypter (attached to the thorax) is completely absent or is represented by a very narrow, inconspicuous membrane.

ABDOMEN

The abdomen of the female is composed of six visible tergites and sternites. The first and second tergites are partly united, but the separating suture is visible at least centrally. The tergites and sternites are well separated laterally by the rather broad pleural regions. In the female, the seventh segment—the basal segment of the ovipositor—is modified into a heavily sclerotized, undivided, nonretractile, conical tube. When the eighth and ninth segments, which form the membranous ovipositor, are retracted, the seventh segment is bluntly truncate distally.

In the male there are only five sternites which are complete. The fifth is the largest; it has the posterior margin in the shape of a broad V and usually is rolled inward somewhat but lacks the lobes and processes often associated with the fifth sternite in the higher Diptera. The sixth, seventh, and eighth sternites are greatly reduced and consist of narrow sclerotized strips stretching along the left side of the sixth tergite.The seventh and eighth tergites are apparently partly united with the sternites. The clockwise torsion inversion (Crampton, 1942) of the terminal segments is plainly evident in the male agromyzids. The abdomen is terminated by the ninth tergite, or andrium, and the closely associated proctiger.

MALE TERMINALIA

(Figs. 3, 4, 5, 6, 7)

The male terminalia of the species within the family Agromyzidae are of the muscoid type. The terminalia of *Agromyza reptans* Fallén typify in general the form to be found throughout the family. Although terminalia of some species in the families Tephritidae, Anthomyiidae, and Muscidae were studied to aid in homologizing the various parts, no attempts are made to trace the relationships between the families.

The work of Cole (1927) has been valuable for the descriptions and figures of the terminalia of species in related families. Snodgrass (1935) briefly considered the terminalia of the higher Diptera, and Crampton (1942) summed up all previous studies in a comprehensive paper. The latter work has been followed in interpreting and naming the various sclerites and areas.

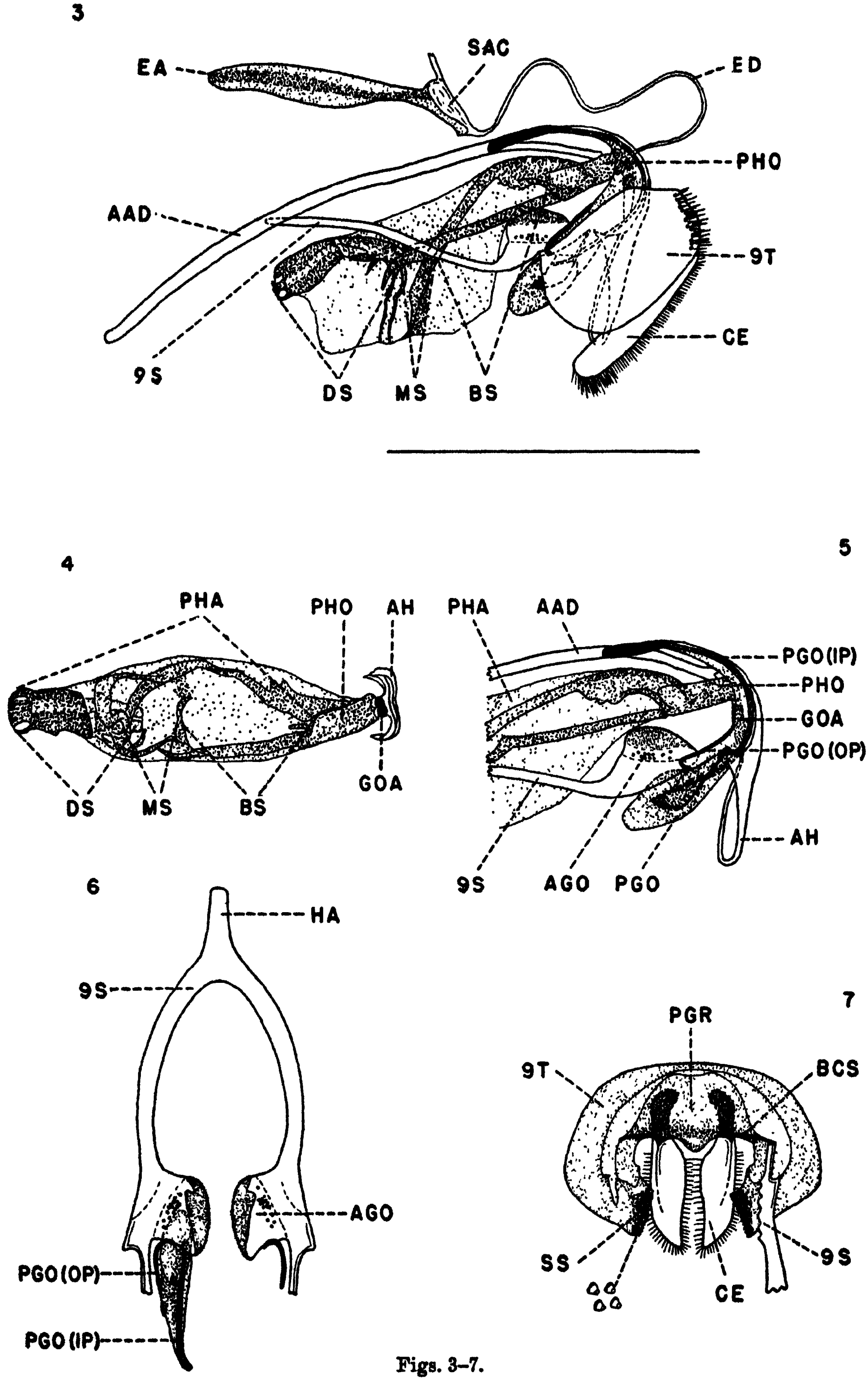
The male terminalia of *Pegomyia hyoscyami* (Panzer), Anthomyiidae, which Crampton frequently uses to illustrate the various parts, are apparently more generalized than are those of the Agromyzidae. Because the postgonites (Pgo) attach posteriorly to the phallophore or base of the aedeagus in the Anthomyiidae, it is assumed that the phallophore (Pho) has migrated up over the aedeagal apodeme (Aad) carrying the attachments of the postgonites far forward in the Agromyzidae (figs. 3, 5). The phallophore in *Pegomyia* is infolded and is hollow ventrally, probably to allow the aedeagus to fold into it, and it is not inconceivable that the phallophore could migrate anteriorly and enfold the aedeagal apodeme. The posterior portion of the phallophore free of the aedeagal apodeme is short and is anteriorly directed.

The ninth sternite (9 S) (figs. 3, 5, 6, 7) is often termed the hypandrium. In the agromyzids it bears long, relatively slender sidepieces which sometimes bear laterally a pair of posteroventral processes near the ninth tergite. The sidepieces are described as thickened when they are enlarged vertically, and as broadened when they are widened laterally, the inner margins approaching each other centrally. The ninth sternite is sometimes elongated anteriorly, as in *A. reptans,* into an internal projection, the hypandrial apodeme (Ha). This apodeme is always small and is absent in some genera. The vertical curvature of the ninth sternite and the direction—whether ventral or dorsal—of the hypandrial apodeme vary with the genera. The posterior arms of the ninth sternite, i.e., the pieces posterior to the attachment with the ninth tergite, curve dorsally to a greater or lesser degree and vary in length from very short, as in *A. reptans,* to very long, being approximate dorsally. It is the posterior arms that attach to the bacilliform sclerites (Bcs) (fig. 7).

The pregonites (Ago) (figs. 5, 6) are borne on the ninth sternite and, as in *A. reptans,* they are broadly united with the ninth sternite in most genera, although in a few they are separate except for a single point of attachment. In all genera the pregonites are flattened plates bearing a number of sensory pores and sometimes one or a few small setae. The pregonites never form long ventral processes in the family Agromyzidae.

The ninth tergite or andrium (9 T) (figs. 3, 7) is in general of the form illustrated. Posterior to it is the proctiger (Pgr) (fig. 7), which consists of the tenth and eleventh segments and the telson. The eleventh segment bears the cerci (Ce), and the telson bears the anus. The cerci are always dorsally situated, well removed from the surstyli (Ss). The surstyli, the appendages of the ninth tergite, are ventral, and where the ninth tergite is broadened longitudinally, the surstyli are usually situated anteriorly.

The posterior arms of the ninth sternite are connected by the bacilliform sclerites directly to the cerci and indirectly to the surstyli (fig. 7). If the posterior end of the aedeagal apodeme terminates anterior to the ninth tergite, as in *A. reptans,* or if the aedeagal hood is small, the bacilliform sclerites (Bcs) may be broadly united by a thin membrane. Usually the bacilliform sclerites are separate as far as their junction with the cerci, which are united within the ninth tergite. The surstyli, being anterior and ventral, usually are broadly joined to the bacilliform sclerites. The surstyli may be completely united with the ninth tergite, as in *A.*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9S
AGO
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PGO(IP)
7
PGR
9T
BCS
SS
9S
CE

Figs. 3–7.

reptans; or they may be separated from it by a suture on the outer margin or completely separated by a suture. When such a suture is present, the connection of the surstyli to the bacilliform sclerites is usually narrow. The surstyli may have numerous spines, as in *A. reptans,* which may be blunt or sharp; or they may have only a single spine, or only setae of varying lengths. The surstyli are visible in lateral view of the ninth tergite when they are directed ventrally; they are invisible, as in *A. reptans,* when directed inward or dorsally.

The aedeagal apodeme (Aad) is always rodlike and is usually very long, extending usually to the third abdominal segment, and even to the second in certain species. Posteriorly it may terminate anterior to the margin of the ninth tergite, as in *A. reptans,* or it may be longer. During copulation this apodeme can be shifted posteriorly so that the aedeagus is well behind the ninth tergite.

The aedeagal hook or epiphallus (Goa) is always moderately small in the Agromyzidae and may be very short and blunt in some genera. The structure labeled the aedeagal hood (Ah) may be very large, as in *A. reptans* (fig. 5), or it may be quite inconspicuous. This structure was not stressed by Crampton and others, but it appears to be what Huckett called the ejaculatory hood. This term has been used in a number of senses, and it is rejected here. The hood is attached to the elongated phallophore anteriorly and is capable of being rather widely spread during copulation. The hood may be much shorter than the phallophore, as in *A. reptans,* or it may nearly equal it, as in *Liriomyza.*

The postgonites (Pgo) (figs. 5, 6) are carried dorsally and anteriorly by the migrating phallophore. They are always large and are of various forms. Those of *A. reptans* are highly modified, but the basic pattern is the same throughout the family. The dorsal portion consists of a variously modified inner process (Ip) which is attached to the ventral portion and usually extends dorsally to the anterior edge of the phallophore. Centrally there is a connection with the pregonite (Ago) (fig. 5) from which the outer process (Op) arises. This process may be very short, as in *A. reptans,* or it may be as long as the inner process and may also attach to the phallophore. The outer process, when not elongate, is connected to the phallo-

Figs. 3–7. Male terminalia of *Agromyza reptans* Fallén. The solid line represents 0.5 mm.

Fig. 3. Lateral view, abdomen removed.

Fig. 4. Dorsal view of aedeagus and basal structures.

Fig. 5. Lateral view, ninth tergite removed to show attachment of postgonite and associated structures.

Fig. 6. Ninth sternite, dorsal view, portion of postgonite shown to illustrate attachment.

Fig. 7. Interior view of ninth tergite, showing attachments of ninth sternite.

9 T	ninth tergite	Aad	aedeagal apodeme
Ss	surstyli	Ah	aedeagal hood
Pgr	proctiger	Goa	epiphallus or aedeagal hook
Ce	cercus	Pho	phallophore
Bcs	bacilliform sclerite	Pha	phallus
9 S	ninth sternite	Bs	phallus, basal section
Ha	hypandrial apodeme	Ms	phallus, median section
Ago	pregonite	Ds	phallus, distal section
Pgo	postgonite	Ed	ejaculatory duct
Pgo (Ip)	postgonite, inner dorsal process	Sac	ejaculatory bulb
Pgo (Op)	postgonite, outer dorsal process	Ea	ejaculatory apodeme

phore by a very thin membrane. In some genera the outer and inner processes are broadly united. Ventrally the postgonites assume various forms: usually they are like blunt teeth. The postgonites sometimes bear one or two short setae, posteriorly directed and subventrally situated.

The phallus (Pha) consists of all of the aedeagus except the phallophore and is composed of three sections (figs. 3, 4). Crampton uses the terms hypophallus and paraphallus for the parts of the phallus of *Phormia regina* (Meigen), but the areas appear to be too modified to fit the observed agromyzid pattern. The three sections—termed the basal section (Bs), median section (Ms), and distal section (Ds)—are greatly modified in some genera, and their limits are difficult to define. The basal section typically consists of two irregular sclerites of varying lengths that bear distally a pair of ventral projections (one of these in *A. reptans* is rudimentary, being simply a slight darkening of the membrane). These paired sclerites vary greatly in width, and in some genera unite to form a nearly complete tube. The median section is generally much shorter, is usually more or less tubular, and usually bears a pair of very small ventral projections, which are usually situated distally, as in *A. reptans*. The third and distal section may be heavily sclerotized and nearly tubular, as in *A. reptans*, completely membranous, or greatly shortened and folded back over the median section to form a complex of sclerites. The tip may be variously modified but usually consists of paired openings. Sometimes a pair of proximal ventral processes is present, as in *A. reptans*.

The ejaculatory duct (Ed) enters the proximal end of the aedeagus (fig. 3). Some distance anterior to this the duct is broadened into a bulblike expansion (Sac). Attached to one side of this bulb is the ejaculatory apodeme (Ea). This apodeme varies greatly in size and form among the genera.

Larva

The known larvae of the species in the family Agromyzidae are approximately cylindrical, as in the cyclorrhaphous Diptera, but most are relatively shorter and broader. The larvae are usually widest near the middle and taper slightly to the posterior end and strongly to the anterior. The average *Phytomyza* larva is about two and one-half times as long as wide; in *Agromyza* the larva is about five to six times as long as wide; and the larvae of the cambium miners in *Phytobia* are extremely slender, being eighteen times as long as wide. The color varies from glistening white to dull cream to a distinct yellow; the yellow is usually confined to the anterior half of the body.

HEAD AND PROTHORAX

(Figs. 8, 10, 11, 12, 14)

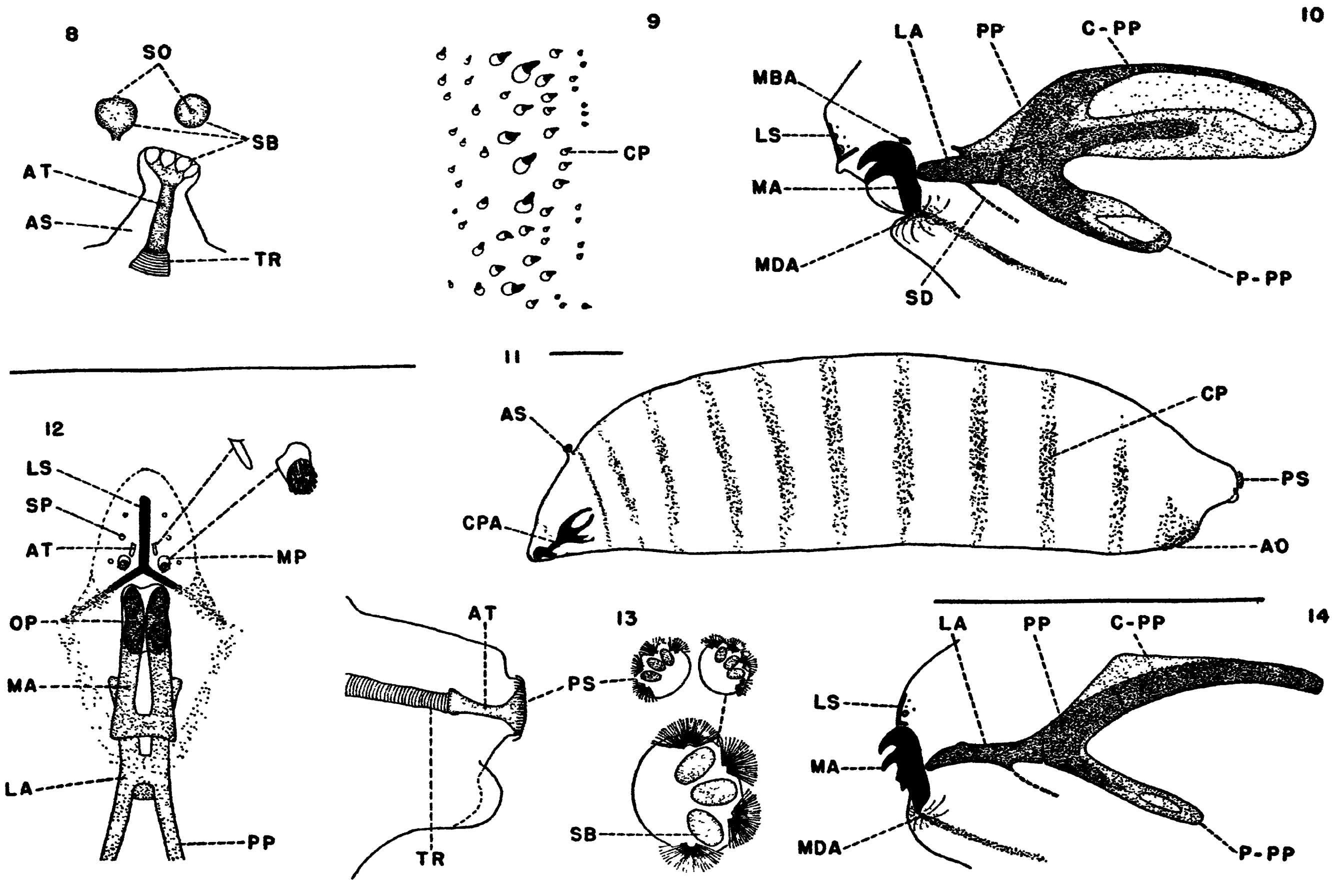
The interpretations published by Cook (1949) and Ludwig (1949) are accepted throughout, because their conclusions are the result of a thorough study of the enervation, musculature, and embryology of the head and prothoracic region of dipterous larvae. The mouth hooks, in reality the mandibles (Ma), are always united basally and always work as a unit. There are one or two well-developed teeth, and rarely a weaker third tooth, on each mandible. The right mandible (viewed from above) is usually the larger, making the number of teeth appear

double in lateral view; this is not the case in *A. reptans* (fig. 10). The mandibles work perpendicularly or obliquely to the anterior process of the cephalopharyngeal apparatus (Cpa), instead of with the parallel or continuous action of all other leaf-mining muscoid Diptera.

The anterior process of the cephalopharyngeal apparatus is the labial sclerite (La). It is visibly undivided, and it has no anteriorly projecting processes, although the process from the phragma posterior may appear to originate from the labial sclerite. The phragma posterior to the labial sclerite is the paraclypeal phragma (Pp), which is paired. These phragmata may be greatly broadened, as in *A. reptans* and other members of the subfamily Agromyzinae (fig. 10), or quite slender, as in the subfamily Phytomyzinae (fig. 14). The paraclypeal phragma may be completely separated from the labial sclerite, or only partly so, as in *A. reptans*. This phragma is produced posteriorly into a dorsal and a ventral process. The dorsal process (C-pp) is the fused cranial phragma and prothoracic phragma. The dorsal process is not sclerotized centrally in the subfamily Agromyzinae; a dorsal and a ventral arm therefore appear to be present. The dorsal and ventral arms may meet posteriorly but are usually approximate. The ventral portion (P-pp) is composed of the posterior elongation of the paraclypeal phragma to which is fused the pharyngeal phragma. This ventral process is usually shorter and smaller than the dorsal process. It rather infrequently has a weakly developed dorsal arm, as in *A. reptans*. The ventral process may be slightly expanded posteriorly. The salivary duct (Sd) passes between the united plates of the labial sclerite, entering ventrally.

Two small sclerites associated with the mandibles and the cephalopharyngeal apparatus may be present. Posterior to and ventrad of the mandibles is a small sclerite, the mandibular adductor apodeme (Mda). This is very lightly sclerotized in most genera and is difficult to discern. Dorsad of the mandibles is another small sclerite, the mandibular abductor apodeme (Mba). This sclerite is not usually visible. These sclerites serve as points of attachment for the powerful muscles that move the mandibles.

The teeth of the mandibles extend out of the oral opening (Op). The true mouth is posterior to this opening, being internal. Dorsad of the mandibles are a pair of rudimentary antennae (At), equally rudimentary maxillary palpi (Mp), and a variable number of minute sense papillae (Sp), which appear as tiny circles in the cuticle. Above the mandibles is a relatively long, slender, strongly sclerotized area (Ls), called the *Lippenrand* by de Meijere, who suggested that this darkly pigmented rod might be the labrum. Ludwig (1949) has shown that the labrum is a membranous internal structure in the larvae of the Cyclorrhapha and that the prothorax forms a narrow fold over the head which extends anteriorly to the oral opening. This sclerite is therefore of prothoracic origin and is here termed the longitudinal sclerite (Ls). In some genera, particularly *Napomyza* and *Phytomyza*, a short, rod-shaped process may be present dorsad of the antennae. This is termed the *Stirnfortsatz*, or frontal process, by de Meijere (1925). Its homology is not known, but it would appear to be of prothoracic origin. This process is directed ventrally and is sometimes enlarged distally, so that it appears club-shaped.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MA
MDA
P-PP

Figs. 8–14.

BODY

(Figs. 9, 11, 13)

The larva consists of a small head region, three thoracic segments, and eight abdominal segments. The anal opening (Ao) is ventrally situated on the last abdominal segment. All the thoracic and usually all the abdominal segments have a band consisting of minute cuticular processes (Cp) (figs. 9, 11). The bands are well developed laterally, weakly developed dorsally, but are usually absent ventrally. The cuticular processes are usually subtriangular, being more or less pointed distally. In color they vary from heavily and darkly pigmented to colorless. Their form on the prothorax is always distinct from that on the other segments. In *A. reptans* the cuticular processes on the prothorax are extremely minute and are in short, straight rows. There are usually no anal tubercles or protuberances.

The first-stage larva is metapneustic, having only a single pair of spiracles or stigmata on the eighth abdominal segment. The second and third stages are amphipneustic; that is, they have two pairs of spiracles, one dorsally situated on the prothorax (As) and the other (Ps) on the eighth abdominal segment (fig. 11).

The posterior spiracles of *A. reptans* are atypical, the three spiracular bulbs being surrounded by patches of setulae (fig. 13). The anterior pair (fig. 8) are of the usual type and consist of a variable number of spiracular bulbs (*Knospen* of

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Larva of *Agromyza reptans* Fallén

Figs. 8, 9, 10, 12, and 13 are drawn to the same scale; the longest solid line represents 0.5 mm. Fig. 11 is drawn to a different scale; the shortest solid line represents 0.5 mm.

Fig. 8. Anterior spiracle, lateral view.

Fig. 9. Cuticular processes on lateral aspect of fourth abdominal segment.

Fig. 10. Head and prothoracic structures, lateral view.

Fig. 11. Third instar larva, lateral view.

Fig. 12. Head and prothoracic structures, ventral view. Maxillary palpus and antenna greatly enlarged.

Fig. 13. Posterior spiracles; left, lateral view; right, posterior view; lower, right spiracular plate greatly enlarged.

Larva of *Phytomyza atricornis* Meigen

Fig. 14. Head and prothoracic structures, lateral view. The solid line represents 0.5 mm.

Head

Ma	mandibles
Cpa	cephalopharyngeal apparatus
La	labial sclerite
Pp	paraclypeal phragma
C-pp	dorsal process of paraclypeal phragma
P-pp	ventral process of paraclypeal phragma
Mba	mandibular abductor apodeme
Mda	mandibular adductor apodeme
Sd	salivary duct
Op	oral opening
Mp	maxillary palpus
At	antenna
Sp	sense papilla
Ls	longitudinal sclerite

Body

Cp	abdominal cuticular processes
As	anterior spiracle
Ps	posterior spiracle
Sb	spiracular bulb
So	spiracular opening
At	atrium
Tr	trachea
Ao	anal opening

de Meijere) (Sb), each bearing a minute, circular pore containing the spiracular opening (*Tüpfeln*) (So). The bulbs are usually subspherical, but in some genera they become elongated, and thus form a complex pattern. The number of spiracular openings per spiracle varies from a total of three (the generalized number) to as many as thirty in the more specialized genera. The bulbs are at the distal end of the atrium (*Filzkammer*) (At), which connects directly to the trachea (Tr).

From a physiological standpoint, the Agromyzidae form a unique group in having calcium carbonate crystals deposited in cells connected to the fat body. Henneguy and Giard (1897) were the first to find these crystals within the larvae. They studied only the larvae of *Phytomyza atricornis* Meigen and *Napomyza lateralis* (Fallén), and they concluded that the presence of these bodies is either abnormal or seasonal. Keilin (1921) found that the deposition of the crystals is peculiar to the family Agromyzidae. These bodies, called calcospherites, are not uncommon in the Malpighian tubules of dipterous, leaf-mining larvae. In agromyzids, the cells containing the calcospherites are always connected with the fat body, although they never contain droplets of fat. The cells lie, as a rule, in the alveolar spaces formed among the fat cells. The author has found calcospherites to be present, at least to some extent, in the larvae of all genera studied. The calcospherites are not found in the embryos or in larvae just hatched, but they appear after a short feeding period.

SYSTEMATIC TREATMENT

Historical Background

The first agromyzid to be described was *Musca ranunculi* Shrank, 1803, a fly which had been previously mentioned and illustrated by Réaumer (1737). Several years later, Panzer (1806) described *Chlorops denticornis,* a species which subsequently became the type of *Cerodontha* Rondani. The genera *Agromyza* and *Phytomyza* were erected by Fallén (1810) within the family Micromyzides. Fallén originally noted that there were three Swedish species of *Agromyza* and nine of *Phytomyza,* although he listed none specifically. However, he illustrated a wing of *Phytomyza flaveola,* a species which he did not mention again. In subsequent papers (1820, 1823*a, b*) Fallén described numerous species and erected the families Agromyzides and Phytomyzides.

Meigen (1830) recognized sixty-nine species in the genus *Agromyza* and twenty-eight in *Phytomyza,* his distinction between the two genera being that in *Phytomyza* the posterior cross vein is either absent or situated very close to the wing base. Meigen placed *Chlorops denticornis* Panzer within his concept of *Agromyza.*

In the meantime, Macquart (1835) placed *Agromyza* and *Phytomyza* in the subtribe Heteromyzides, family Muscides, and described a great many new species in the two genera. He also erected the genus *Odontocera* (preoccupied) to include *Chlorops denticornis* Panzer (as the type) and three related species, and the genera *Cnemacantha* and *Leiomyza* to receive certain of Meigen's atypical species of *Agromyza.* Macquart noticed a phylogenetic significance in the gradual approach of the two cross veins to the base of the wing. He stated that *Phytomyza,* aside from having these cross veins very close together or lacking them entirely, retained all the characters of its tribe.

In his final paper on the group, Meigen (1838) listed 101 species in *Agromyza* and 40 species in *Phytomyza.* He recognized *Odontocera* and *Leiomyza* as distinct genera, but did not consider *Cnemacantha* as a genus and returned it to *Agromyza.*

Westwood (1840) recognized the family Phytomyzides, which included the genera *Milichia* Meigen (Milichiidae), *Leucopis* Meigen (Ochthiphilidae), *Asteia* Meigen (Asteiidae), *Agromyza,* and *Phytomyza.* He subdvided the genus *Agromyza* into four subgenera: *Agromyza* Fallén, *Phyllomyza* Fallén (Milichiidae), *Odontocera* Macquart, and *Leiomyza* Macquart (Asteiidae). *Phytomyza* contained the subgenus *Napomyza,* a manuscript name used by Haliday. Westwood listed a "typical species" after each genus, and these are now considered as type designations.

Zetterstedt (1840, 1842, 1848, 1860) described many new species and set forth new concepts of the families Agromyzides and Phytomyzides. In 1848, he included in the Agromyzides the genera *Agromyza* and *Selachops* Wahlberg as well as a large number of genera now in the families Milichiidae, Aulacigasteridae, Phyllomyzidae, and Piophilidae. In the Phytomyzides, he included only *Lonchoptera* Meigen, 1803 (synonym of *Musidora* Meigen, 1800) (Musidoridae), and *Phytomyza.* In 1860, he added *Chlorops denticornis* Panzer to the Agromyzides.

Among the biologists of this period, Curtis (1832, 1844, 1845, 1846), Goureau (1846, 1851), and Kaltenbach (1856, 1858, 1859, 1860, 1862, 1864, 1867, 1869, 1874) may be mentioned. These workers described, and sometimes figured, immature stages and mines, listed host plants, and gave general life histories.

Rondani (1856) divided the genera now placed in the family Agromyzidae into and stirpes Agromyzina, Oscinia, and Astejina. He specifically designated types, some of which he changed in a subsequent paper. In 1875 Rondani enlarged and more thoroughly characterized the stirps Agromyzinae, describing many new species, some so briefly that they have not been recognized by subsequent workers.

Loew (1862) recognized the families Agromyzidae and Phytomyzidae. In the Agromyzidae he placed *Agromyza, Lobioptera* Wahlberg, and *Milichia* Meigen, whereas under Phytomyzidae he mentioned only *Phytomyza* as being North American.

Lioy (1864) recognized the subfamilies Agromyzini and Phytomyzini and erected seven new genera, the names of most of which were preoccupied. Hendel (1910) considered Lioy's work inferior and ignored it. Coquillett (1911) pointed out that Lioy's papers meet the requirements of the International Rules of Zoölogical Nomenclature and therefore cannot be ignored.

Schiner (1864), in a monograph of the Diptera, included in the Agromyzidae the genera *Agromyza, Ceratomyza* (n.n. for *Odontocera*), *Phyllomyza* Fallén (Milichiidae), and *Phytomyza.* He removed other genera previously placed in the Agromyzidae, and placed *Lobioptera* Wahlberg, *Milichia* Meigen, and *Cacoxenus* Loew in Milichiidae, and *Acrometophia* Schiner, *Ochthiphilia* Fallén, and *Leucopis* Meigen in the Ochthiphilidae.

Osten Sacken (1858), in a catalogue of North American Diptera, listed but two species. One, *Agromyza tritici* Fitch, has since been shown to belong in the genus *Meoneura* Rondani (Carnidae). The other species was *Phytomyza obscurella* Fallén. In a revision of the catalogue, Osten Sacken (1878) listed seventeen North

American species in the genus *Agromyza*, including *A. tritici*. *Odontocera* (preoccupied) contained *dorsalis* Loew, and *Phytomyza* included seven species. Of the twenty-five species listed, sixteen had been described by Loew (1863, 1869).

Strobl was the only European worker from 1880 to 1903 actively to study the family. He published a series of papers (1880, 1893*a*, *b*, 1894, 1897, 1898*a*, *b*, 1900*a*, *b*, 1901, 1902, 1904, 1906, 1909, 1910) dealing with faunal areas, in which he described a great many new species. Some of his papers are in obscure journals, and they have been overlooked by many workers. His large collection was invaluable to Hendel when the latter began his monographic studies. Becker, like Strobl, described many new species from faunal areas (1903*a*, *b*, 1907*a*, *b*, 1908*a*, *b*, 1910, 1912, 1919).

Toward the end of the nineteenth century, Coquillett began to publish descriptions of many North American Diptera, including some agromyzids (1895*a*, *b*, 1898, 1899, 1900*a*, *b*, *c*, 1902, 1904, 1910*a*). Only a very few species from this region had been described previously. Coquillett was the first American worker actively to study the family.

Melander (1913) utilized new characters of phylogenetic importance. He found that the direction of inclination of the postvertical setae, the manner of fracture of the basal portion of the costa, and the finer structures of the head were of far more importance than the structure and form of the proboscis, legs, and venation, particularly of the outer part of the wings.

On this basis, Melander placed together the genera *Agromyza*, *Domomyza* Rondani, *Cerodontha*, *Liriomyza* Mik, *Antineura*, n. gen., *Napomyza* Westwood, *Phytomyza*, *Traginops* Coquillett, *Odinia* Robineau-Desvoidy, *Neoalticomerus* Hendel, and *Cryptochaetum* Rondani. Melander was the first to limit the family Agromyzidae to those genera in which the species have the postvertical setae divergent.

Malloch, in a long series of papers (1913*a*, *b*, 1914*a*, *b*, *c*, *d*, 1915*a*, *b*, *c*, 1916*a*, *b*, 1918*a*, *b*, *c*, *d*, 1920, 1923, 1924*a*, *b*, 1925, 1927, 1932, 1934*a*, *b*, 1935*a*, *b*), described a large number of species. A series of these papers was devoted to species in the Australian region and a smaller number to Neotropical species.

Hendel's revolutionary "Prodromus einer Monographie" (1920) was the culmination of years of study of European collections. He had examined all available European types, although there were some, including a few of Meigen, that he did not find. Hendel erected four new genera—*Melanagromyza*, *Dizygomyza*, *Phytagromyza*, and *Pseudonapomyza*—and reëstablished *Ophiomyia* Braschnikov, 1897, and *Liriomyza* Mik, 1894, which had been overlooked.

Hendel was not able to distinguish between the types of some species, especially in the complex of similar species in the genus *Liriomyza*. He therefore collaborated with Hering, a biologist at Berlin, and with de Meijere at Amsterdam, a student of dipterous larvae, in a more thorough study of the problem. This partnership was divided so that Hering described the leaf mines, de Meijere described the larval and pupal characters, and Hendel described the adults.

Frost (1924) published a paper on the known biologies of all North American species, including descriptions of larval forms, host-plant records, and types of mines. His systematic arrangement followed that of Malloch (1913*a*) for the genus *Agromyza*, and that of Melander (1913) in the genus *Phytomyza*. No American

student has contributed more than descriptions of new species since the work of Frost.

The last worker to redefine the family and to establish new generic concepts was Enderlein (1936*a*, *b*). He recognized the Agromyzidae s.s. and separated the Odiniidae. Enderlein erected thirteen new genera, resurrected *Domomyza* Rondani, and raised Hendel's subgenera *Tylomyza* and *Haplomyza* to full generic standing. However, he differentiated genera on many phylogenetically questionable characters, such as the presence, position, or absence of the m-m cross vein, the costal termination (whether at R_{4+5} or M_{1+2}), the number of pairs of dorsocentral setae, and the length of the proboscis.

Systematic Relationships with Other Families

The family Agromyzidae belongs to the group Cyclorrhapha Brauer (1880), suborder Schizophora Becher (1882), series Acalyptratae Macquart (1835), and to the morphological group Schizometopa Brauer (1880) as amended by Hendel (1922*b*, 1928).

The Milichiidae, Ochthiphilidae, and Odiniidae were included within the Agromyzidae by early workers. Malloch (1913*b*) considered the odiniids as genera within the family Agromyzidae, and the milichiids and ochthiphilids as subfamilies. Melander (1913) gave the milichiids and ochthiphilids family rank. Hendel (1920) gave the odiniids subfamily rank.

In 1922, Hendel erected the schizometopous superfamily Milichioidea to accommodate the families that have the upper and lower fronto-orbital setae present: Odiniidae, Agromyzidae, Carnidae, and Milichiidae. Malloch (1926) described the genus *Schildomyia* as a member of the Agromyzidae, but I have placed it in the Odiniidae.

Frey (1921), on the basis of the mouthparts, erected the acalyptrate divisions Haplostomata (hyoid sclerite—*Gelenkkapsel* of Frey, *Theca* of Hendel—absent) and Thecostomata (hyoid sclerite present). The Agromyzidae belong to the Haplostomata and to the series Ortalidiformes, which includes families such as the Lonchaeidae, Otitidae, Tanypezidae, and Tephritidae. This series has the galea small, lancet-like, and not wider than the maxillary apodemes (*Stipes* of Frey); the fulcrum without a filtering apparatus; the mediproboscis (*Unterlippenbulbus*) usually with basilateral sclerotized carinae; the prementum usually with basal incisions on each side; and the female with a projecting, nonretractile basal segment of the ovipositor.

Hendel (1931*a*) pointed out that the agromyzids were strikingly removed from the Milichioidea on the basis of the number of visible abdominal segments, the peculiar form of the basal segment of the ovipositor, and the rasping apparatus of the eighth abdominal segment, which forms part of the ovipositor. Hendel stressed the form of the ovipositor, and similar biologies, in placing the agromyzids in the series Ortalidiformes.

Crampton (1944) tentatively arranged the principal families of the Acalyptratae on the basis of the male terminalia. The family Agromyzidae fits into the first division (Syrphomorpha), with the sixth abdominal sternite asymmetrically developed; and into section B (Otitiformes), with tergites 6 to 8 atrophied and with corresponding sternites clustered on the left side.

Hendel (1928) designated the term *Schizometopie* to include the adult flies placed in Schizometopa Brauer (1880) (= Calyptratae Macquart, 1835) and also certain acalyptrate families with similar head structure. In the schizometopous families the membranous frontal vitta is separated on each side from the compound eyes by continuous genovertical plates. This condition is found in such diverse families as Agromyzidae, Tephritidae, Milichiidae, Carnidae, Anthomyzidae, Muscidae, Larvaevoridae, Dexiidae, and Sarcophagidae. In the Agromyzidae and Tephritidae the frontal vitta are of approximately equal width in both sexes.

On the basis of the form of the genovertical plates, mouthparts, female terminalia, and biologies, the Agromyzidae are more closely related to the group containing the families Otitidae and Tephritidae. The family is clearly removed from allied families, not only on the basis of adult morphology but also on that of the larvae.

The genus *Fergusonina* Malloch (1925) does not belong in the family Agromyzidae. Tonnoir (1937) proposed the subfamily Fergusoninae for this genus because he hesitated to erect a new family within the Acalyptratae. I have not seen any material representing *Fergusonina.*

The genus *Cryptochaetum* Rondani (1875) has been referred to the Agromyzidae by many early workers. The larvae of the species in the genus are all internal parasites of scale insects of the subfamily Monophlebiinae. The adults agree with agromyzids in having a very minute pair of divergent postvertical setae. The costa, however, is broken in two places, and this character alone would remove *Cryptochaetum* from the Agromyzidae. A number of recent workers have considered the genus as representing a distinct family, the Cryptochaetidae.

Family AGROMYZIDAE Fallén

Agromyzides Fallén, 1823, Dipt. Suec., Agromyzid., 2 (37) :1.

Agromyzinae Schiner, 1864, Fauna Austr., Flieg., 2:299; Brauer, 1883, Denkschr. Akad. Wiss., 47:41; Melander, 1913, Jour. N. Y. Ent. Soc., 21:246.

Agromyzidae Williston, 1896, Manual N. A. Dipt., 2d ed., p. 102; Becker *et al.*, 1905, Kat. palaearkt. Dipt., 4:240; Malloch, 1913, Proc. U. S. Nat. Mus., 46:129; Hendel, 1920, Arch. Naturgesch., Abt. A., 84:109; Frost, 1924, Cornell Mem., 78:33; de Meijere, 1925, Tijdschr. Ent., 68:199; Hering, 1927, Tierw. Deutschl., 6:1; Hendel, 1928, Tierw. Deutschl., 11:100, 101, 103; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:1; Curran, 1934, N. A. Dipt., p. 332; Enderlein, 1936, Tierw. Mitteleur., 6 (3) :178; Kloet and Hincks, 1945, Check List Brit. Insects, p. 401.

Phytomyzides Fallén, 1823: Westwood, 1840, Introd. Classif. Insects, Gen. Syn., 2:151; Walker, 1853, Insecta Brit., Dipt., 2:241; Walker, 1857, Trans. Ent. Soc. London, 4:232.

Type.—Agromyza Fallén, 1810.

Adult.—Small, 1 to 5 mm. in body length. Solid black or dull gray in basic color, but usually marked with yellow.

Head: Compound eyes naked to distinctly haired; widely separated in both sexes. Head structure schizometopous, i.e., parafacial plates composed of genal plates extending up between frontal suture and compound eyes to meet the vertical plates, the resulting genovertical plates, or orbitals, becoming continuous sclerotized plates occupying the whole length of frons; no visible separation between the vertical plates, each of which bears one to three upper fronto-orbital setae (absent in males of *Tylomyza*), and the genal plates, each of which bears the inward-directed lower fronto-orbital setae. Frontal vitta naked, or with only scattered microscopic hairs; of equal width in both sexes. Ocellar plate relatively small, seldom wider than long; at vertex; ocellar setae present. Postvertical setae strongly divergent (absent in *Xeniomyza*). Antennae decumbent,

relatively short; second segment short, with an outward-directed dorsal seta; third segment rounded or longer than wide, never strongly elongate, sometimes with a sharp or pointed angle or with a spine distally; arista nearly naked to short pubescent, inserted dorsally near base of third segment. Mesofacial plate with distinct antennal bases, centrally a longitudinal or rounded median carina, which is seldom prominent; rarely a broad epistoma (postclypeus) above subcranial margin. Parafacial and genal areas of variable width and height; genal depression under eyes usually large, naked. Length of proboscis variable, if elongate then subcranial margin as seen in profile somewhat produced laterally and ventrally; galea elongate (Agromyzinae) or absent (Phytomyzinae); maxillary palpi well developed, without palpifers; anteclypeus always plainly visible anteriorly, small; mediproboscis with basilateral sclerotized carinae; prementum without basal projections (Agromyzinae) or these present (Phytomyzinae).

Thorax: Mesonotum somewhat longer than broad, rectangular, not constricted anteriorly, gently arched; transverse suture widely interrupted and invisible centrally; humeri well developed. Following dorsal setae present: 1 h; 0–1 sa; 0–2 ia; 1–2 pa; 1 prs (absent in *Selachops*); 1–2 npl; 1–7 dc; 0–1 prsc; acr variable, usually numerous, rarely absent; 4 sc (2 in *Cerodontha*). Pleural setae present: 1 pp (absent in *Gymnophytomyza*); 1 strong aes, on posterior margin; 1 strong kes.

Legs: Tibiae usually with an apical spur; mid-tibiae usually with 2 spurs, one stronger; mid-tibiae often with 1 or 2 setae near the middle.

Wing: Usually hyaline, at most tinged milky white or brown; covered with small macrotrichiae. Costa broken only at apex of Sc; reaching apex of R_{4+5} or M_{1+2}; Sc either incomplete, becoming a fold distally, ending in costa basad of R_1 (Phytomyzinae), or weakly developed with Sc and R_1 confluent at costa (Agromyzinae); r-m present; m-m present or absent; Pl + Cu usually developed, not reaching wing margin (absent in *Xeniomyza*, a short weak fold in *Ptochomyza*); cell Cu usually closed (open in *Xeniomyza*, appearing so in *Ptochomyza*); axillary lobe and calypter rarely absent.

Abdomen: Composed of six visible segments and the terminalia; sternites separated broadly from tergites.

Ovipositor: Basal segment conical, short to nearly as long as rest of abdomen, nonretractile; usually black, sometimes brown. Sclerotized accessory glands 1 or 2 in number.

Andrium: Flattened, oval; cerci variable, from long, narrow, conspicuous, to minute, short. Usually black, sometimes brown, rarely yellow.

Male terminalia: Aedeagal apodeme long, rodlike; anterior movement of phallophore along the aedeagal apodeme with the posterior portion very short and anteriorly directed; dorsal and anterior movement of posterior articulation of postgonites along with phallophore; pregonites flat, platelike; ninth sternite U-, V-, or Y-shaped; hypandrial apodeme absent or small, narrow, not elongate; aedeagal hood sometimes enlarged; cerci dorsal in position; surstyli anteroventral in position, well separated from the cerci and having an elongate membranous or moderately sclerotized connection between them.

Larva.—Approximately cylindrical, relatively short and broad, usually widest near middle, tapering slightly to posterior, strongly to anterior; about 2.5 times as long as wide (*Phytomyza*), about 5 or 6 times as long as wide (*Agromyza*), or as slender as 18 times as long as wide (cambium miners). Glistening white, dull cream, or yellow—yellow usually on anterior half of body.

Head and prothorax: Mandibles joined at base, working as a unit; large for size of larva; the right, as viewed from dorsal surface of larva, usually longer, making number of teeth appear double in lateral view; 1 to 2 well-developed teeth, rarely a weak third; mandibles working perpendicularly or obliquely to labial sclerite of cephalopharyngeal apparatus. Labial sclerite appearing undivided, of nearly uniform width, of varying length; having no forward-projecting processes, completely or partly separated from paraclypeal phragma. Paraclypeal phragmata paired; sometimes with a slender, anteriorly projecting spine; relatively broad, never completely pigmented; of two generalized forms; broadened dorsally, with heavily sclerotized dorsal and ventral arms, visibly united or approximate posteriorly (Agromyzinae); or straighter and slender, only dorsal arm developed, ventral arm usually absent but if present slenderly sclerotized to nearly length of dorsal arm (Phytomyzinae). Ventral process of paraclypeal phragma shorter than dorsal (subequal in *Ophiomyia*); sometimes having a weakly developed dorsal arm (Agromyzinae). Dorsad of mandibles a pair of rudimentary antennae, rudimentary maxillary palpi, and a variable

number of minute sense papillae; centrally, anterior to mandibles, a relatively long, slender, darkly pigmented, strongly sclerotized process; rarely a short, ventrally directed, rod-shaped process, apex sometimes enlarged, club-shaped, dorsad of antennae.

Body: Consists of 3 thoracic and 8 abdominal segments; all thoracic and most abdominal segments with a band of minute, cuticular processes, in rows or scattered; bands usually weakly developed dorsally, often absent ventrally, weakly developed or absent on anal segment; processes usually subtriangular, more or less pointed, heavily pigmented to colorless, of a different form on prothorax. Anal tubercles usually absent. Spiracles with a variable number of bulbs, 3 to about 30, each bulb containing one minute circular spiracular opening. Calcium carbonate crystals deposited in cells connected to fat body, scattered throughout larval body.

Puparium: Short, thickened; usually flattened ventrally and strongly arched dorsally, or sometimes nearly symmetrical; intersegmental lines usually pronounced, sometimes rather inconspicuous. Anterior spiracles prominent, anteriorly directed, except in leaf-pupating *Phytomyza*, in which turned ventrally. Posterior spiracles prominent, posteriorly directed. White, yellow, red, or black.

Biology: Larvae feed entirely upon living plant tissue, the majority of the species in the genera *Agromyza, Tylomyza, Phytobia, Liriomyza, Haplomyza, Xeniomyza, Cerodontha, Pseudonapomyza, Phytagromyza, Napomyza, Phytomyza*, some *Ophiomyia*, and a few *Melanagromyza* being parenchyma miners in the leaves of plants; about half the *Ophiomyia*, some *Melanagromyza*, and most of the *Phytobia* (*Phytobia*) species are stem miners; some *Melanagromyza* and a few species in scattered genera mine in the pith of stems or form galls on stems and twigs; and a very few species, widely distributed throughout the genera, including *Gymnophytomyza*, mine in buds or rarely in fruits of flowering plants.

PHYLOGENY AND EVALUATION OF CHARACTERS

Wing venation has generally been considered of major importance in determining the genera within the family Agromyzidae. Aside from *Cerodontha* Rondani, with only two scutellar setae, *Agromyza* Fallén, *Phytomyza* Fallén, and *Napomyza* Westwood were orginally based primarily upon the reduction of the costa from M_{1+2} to R_{4+5} and the presence, position, or absence of cross vein m-m.

Domomyza Rondani was erected to include the species of *Agromyza* s.l. in which the costa ends at R_{4+5}. Enderlein (1936*a*) created new genera based on the degree of reduction of the costa. Divisions of this kind are artificial when the reduction is not accompanied by supporting biological, larval, or further adult evidence. In specimens of certain species, in most of the genera, the costa between R_{4+5} and M_{1+2} is very slender, suggesting a future loss of that part of the costa.

Although reflecting the phylogeny of certain major genera when accompanied by the anterior and basal shifting of the longitudinal veins, the reduction of the costa is also of importance within the genera *Agromyza, Melanagromyza* Hendel, *Ophiomyia* Braschnikov, *Phytobia* Lioy, and *Cerodontha*.

Cross vein m-m disappears in certain species throughout each of several genera. Genera having the majority of the species with cross vein m-m are *Agromyza* (absent in 2 species), *Ophiomyia* (absent in 1 species), *Liriomyza* Mik (absent in a few species), *Metopomyza* Enderlein (absent in 1 species), *Cerodontha* (absent in 2 species), *Phytagromyza* Hendel (absent in a few species). The absence of cross vein m-m alone has created confusion about the generic placement of some species. The venational characters, once regarded of generic value, are now considered as reflecting only a phylogenetic arrangement of species within the genera. The uncovering of more constant characters has minimized the importance of wing venation.

The lengthening of the mediproboscis and labella is found in a few species in a number of genera; these are *Melanagromyza. Ophiomyia, Tylomyza* Hendel (all species), and *Phytagromyza.* This character would appear to have arisen independently in each genus, and several species exhibit intermediate stages.

The form of the lunule is of primary importance in segregating eight subgenera within the genus *Phytobia.* Throughout the subgenera there are a number of divergent species possessing characters of more than one subgenus or having different biologies. These subgenera probably reflect a breaking up of the genus *Phytobia* into what will eventually be full genera.

The number of dorsocentral setae (dc) show an apparent phylogenetic reduction in four genera: *Agromyza, Melanagromyza, Tylomyza,* and *Phytobia.* In the first, the number of dc varies from 4 + 1 (27 Palearctic species), 3 + 1 (24 sp.), 2 + 1 (1 sp.), to 3 + 0 (*A. parvicornis* Loew). Within *Melanagromyza,* the number of dc is usually 2 + 0, with 3 + 0 being found in only two species. *Tylomyza,* with two Palearctic species, has 2 + 0 dc in one species and 3 + 0 in the other species. One subgenus has but 3 + 0 dc in *Phytobia,* the rest having 3 + 1 dc. Although the number of dorsocentral setae is usually constant within each genus, a reduction in their numbers alone is not sufficient basis for erecting a new genus.

Certain characters, often minute, show a relative stability throughout the genera. Their value was not realized until recently, when a reassembling of the species to conform with the results of larval and biological studies made a reëvaluation of adult characters desirable. Some of these characters are (1) direction of inclination—dorsal, erect, or anterior—of the orbital setulae, or else their complete absence; (2) the form of the median carina of the mesofacial plate; (3) the presence and number, or absence, of certain thoracic setae, as the ia, prsc, dc, npl, sc; (4) the anterior and basal shifting of the wing venation with the attendant reduction in the length of the costa and in the venation of the cubital and anal areas; (5) the color of the halteres and (6) the color of the scutellum. The value of each of these characters is upheld by the generic differences found in the male terminalia.

A phylogenetic arrangement of genera is difficult, because of the apparent independence of some of the characters and the relative weight that should be given each. Hendel considered *Phytobia* to be the most primitive genus, with *Agromyza* and its allies next, and then *Liriomyza* and the more specialized genera.

An arrangement is here presented to indicate certain relationships and lines of descent found within the family Agromyzidae, with emphasis on the male terminalia. There are two separate lines of development, one represented by the subfamily Agromyzinae and the other by the subfamily Phytomyzinae (fig. 15).

The subfamily Agromyzinae includes the genera *Agromyza, Melanagromyza, Ophiomyia,* and *Tylomyza.* Within this subfamily, *Agromyza* is the most generalized, usually having a presutural dc seta, the male terminalia with the pregonites broadly united to the ninth sternite, the postgonites extending somewhat ventrally, and most larvae with three spiracular openings in the posterior spiracles. *Melanagromyza* occupies an intermediate position but is well removed from *Agromyza* in having black halteres, the pregonites separated from the ninth sternite, and the postgonites more of the *Ophiomyia* type. *Ophiomyia,* with sexual dimorphism, an enlarged median carina, diverging antennae, and pregonites separated from

the ninth sternite and strongly elongate dorsally following the posterior arms of the ninth sternite, is rather far removed from *Melanagromyza*. *Tylomyza*, in which the male terminalia are very similar to those in *Ophiomyia*, is close to that genus but has the median carina greatly enlarged, and anteriorly directed orbital setulae, the latter a character common to the most highly specialized genera. The anterior direction of these setulae probably arose independently in this group.

The subfamily Phytomyzinae includes all other genera within the family. The genera of this subfamily may be divided into three groups on the basis of certain

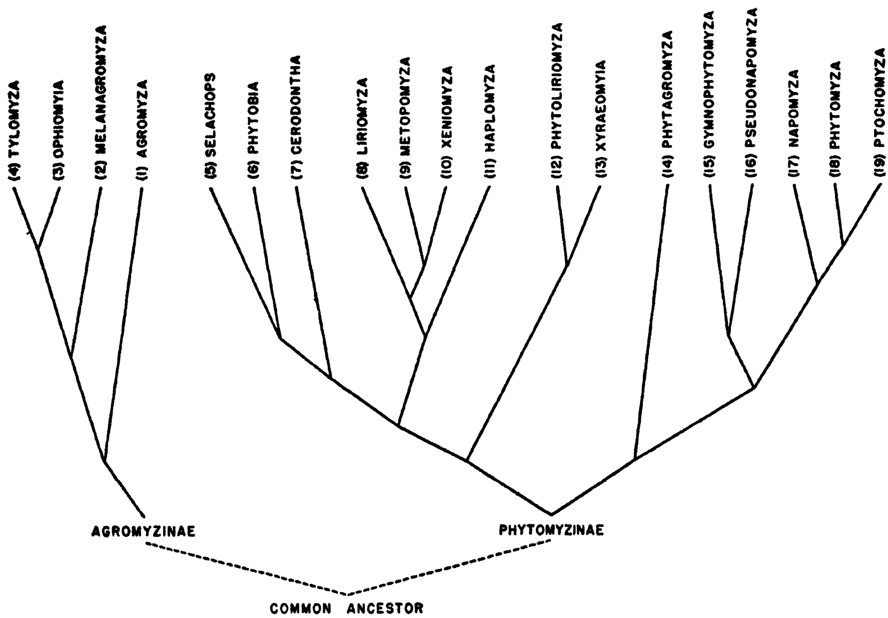


Fig. 15. Phylogenetic arrangement of genera.

characters found both in the adults and in the male terminalia. The most generalized group has two distinct divisions. The more generalized division is represented by *Selachops* Wahlberg, *Phytobia*, and *Cerodontha*. The second division, rather closely related, but having some characters in common with the *Phytomyza* group, contains *Phytoliriomyza* Hendel and *Xyraeomyia*, n. gen. The five genera have few external adult characters in common; those of the male terminalia are more constant. In this group the outer dorsal process of the postgonites extends to the phallophore, the inner process is rarely as long as the outer and it is always separate, the ventral margin of the ninth tergite is usually turned inward and dorsally, the phallophore is always large, and the phallus is distally composed of a pair of tubules or dark rods which terminate separately.

Although *Selachops* is anomalous on the basis of external morphology, the male terminalia place it nearest *Phytobia*. The pregonites bear setae, the postgonites have the outer process the stronger and are not broadened ventrally, the ninth tergite is turned inward posteroventrally and bears blunt spines, and the surstyli are separated by a suture and bear a short, heavy spine. Although certain charac-

ters, such as the presence of setae on the pregonites and the strong outer process of the postgonites, are also to be found in the *Phytomyza* group, *Selachops* is more generalized, particularly in the wing venation and the prominent, broadened geno-vertical plates, the form of which is approached by some *Phytobia,* especially in the subgenus *Poëmyza* Hendel.

Phytobia is generalized in that the adults have the ia seta usually present, usually have a few setae present on the pregonites, the postgonites with the outer process extending dorsally to the phallophore and the inner usually elongate, the ninth sternite sometimes bearing ventral processes, the ninth tergite with the ventral margins turned dorsally and inward and usually bearing one or more strong spines on the posteroventral angles, and the larvae generally with three spiracular openings in the posterior spiracles.

Cerodontha is rather closely related, having the ia seta present, the postgonites with the outer dorsal process strong but the inner process weak, the ninth tergite turned strongly inward and dorsally and bearing strong spines, and the aedeagus similar to some found in *Phytobia.* In common with *Liriomyza, Cerodontha* has no setae on the pregonites.

Phytoliriomyza, although having certain characters in common with the most generalized groups, has others that are similar to those found in the most specialized group, and appears to form a connecting link. In common with the generalized genera, it has the postgonites rounded ventrally, the surstyli partly separated by a suture, the ninth tergite turned inward and dorsally, strong spines on the postero-ventral angles, the aedeagus of the same type as that found in *Cerodontha* and some *Phytobia,* and the sidepieces of the ninth sternite usually bearing ventral processes. *Phytoliriomyza* has the following characters that are like those in the specialized genera: the os setae anteriorly directed, the ia seta absent, the surstyli visible ventrad of the ninth tergite, and the ninth sternite strongly curved dorsally posterior to the pregonites.

Xyraeomyia is very closely related to *Phytoliriomyza.* It is somewhat more highly specialized by the reduction of the number of setae, the absence of cross vein m-m, the great reduction in the size of both axillary lobe and calypter, the ventral margin of the ninth tergite not being turned upward, and the surstyli being united to the ninth tergite and bearing only setulae. The phallus is somewhat like the phalli found in *Cerodontha,* showing a relationship with the more generalized group.

Liriomyza and three related genera form a rather closely related group having in common the ia seta absent or minute, the scutellum mostly yellow, rather similar color patterns, male terminalia with the outer dorsal process of the postgonites usually very short, the inner process usually extending to the phallophore, and surstyli bearing spines or teeth.

Liriomyza appears to be the most generalized, in having the m-m cross vein usually present, the ninth tergite articulated with the ninth sternite near the ventral margin of the former, the ninth sternite usually with short ventral processes, and the surstyli completely separated by a suture and provided with distinct teeth.

The terminalia of *Metopomyza* are rather widely divergent from those of the other genera in this group, but are closest to those of *Xeniomyza.* On the basis of external morphology, *Metopomyza* is placed near *Liriomyza,* from which it differs primarily in possessing prominent genovertical plates. *Xeniomyza* is closely related to *Liriomyza,* but differs from it primarily in having no pvt setae, in having practically no orbital setulae, and in having the surstyli completely united with the ninth tergite, with no sharp angle at the posteroventral angle.

Haplomyza Hendel superficially resembles *Liriomyza* in coloration and in having the surstyli completely separated from the ninth tergite. However, it has certain characters that would indicate affinities with more specialized genera, such as only one pair of sfo setae, few acr setae, a seta on the pregonites (also found in *Selachops* and *Phytobia*), the postgonites terminating ventrally in one or two teeth, and the ninth sternite with very thick sidepieces and bearing no ventral processes.

The more specialized genera within the Phytomyzinae form a more closely related group than those of the generalized genera. This group has in common very strongly developed veins of R_s while M_{1+2} is very weak, being scarcely more than a fold, the extension of the outer process of the postgonites to the phallophore, either united or approximate with the inner process, and the surstyli bearing setae only.

Phytogromyza is the most generalized, and it forms a connecting link, having in common with the more generalized genera the os setae erect, the ia and prsc setae present, the latter rarely absent, cross vein m-m usually present, and the postgonites with the dorsal processes separate and both reaching the phallophore. Of the more specialized genera, *Phytagromyza* has the costa of the wing reaching the apex of R_{4+5}, usually no suture separating the surstyli, the ninth tergite somewhat elongated ventrally, and the ninth sternite usually shortened and strongly dorsally curved posterior to the pregonites.

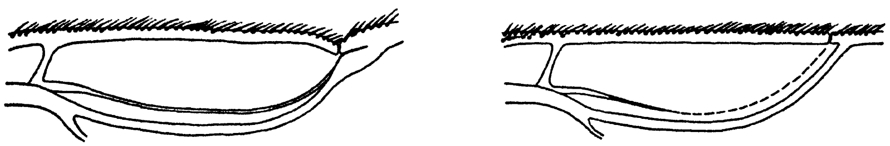
Gymnophytomyza Hendel and *Pseudonapomyza* Hendel have few characters in common, but on the basis of their common characters they are considered as having stemmed from a common origin. Each has only 1 sfo and 3 or 4 ifo setae, the os setae erect, the sidepieces of the ninth sternite thin and elongate anteriorly, and the ninth tergite broadly elongate ventrally.

The two genera are quite widely divergent; *Gymnophytomyza* is probably the more generalized because the costa reaches very slenderly beyond R_{4+5} to M_{1+2}. The absence of the calypter and axillary lobe, in common with *Ptochomyza* Hering, is possibly an independent specialization, *Xyraeomyia* also having these greatly reduced. *Pseudonapomyza,* although possessing cross vein m-m, has the wing venation superficially like that of *Phytomyza,* the cross vein appearing to replace the basal portion of M_{3+4}, and the costa reaching R_{4+5}.

Napomyza is close to *Phytomyza* but appears to be not so highly specialized. Certain characters support this view, and some of these are the presence of cross vein m-m, the postgonites with the two dorsal processes separate with the inner shorter, the ninth sternite not shortened and only moderately dorsally curved, the ninth tergite broadly elongated ventrally, and the phallophore extending far anteriorly over the aedeagal apodeme.

Phytomyza is a very large and highly specialized genus: the cross vein m-m is absent, both dorsal processes of the postgonites are united throughout their length, the surstyli extend somewhat ventrally as well as inward and are separated from the ninth tergite by an inconspicuous suture, the ninth sternite is greatly shortened anteriorly, and posterior to the pregonites it is very strongly curved dorsally.

Ptochomyza has some characters in common with both *Napomyza* and *Phytomyza*. Like *Napomyza*, it has the greatly broadened postgonites, the surstyli not separated by a suture, the ninth sternite rather elongate anteriorly, and the phallophore extending anteriorly very far over the aedeagal apodeme. *Phytomyza*-like characters include the following: slightly more reduced but very similar wing venation, the postgonites with both dorsal processes united, the ninth tergite not



16A 16B

Fig. 16. *a*, section of the base of a wing of *Agromyza ambigua* Fallén, showing the manner in which the Sc and R_1 unite at the costa; *b*, section of the base of a wing of *Napomyza lateralis* (Fallén), showing the manner in which the Sc and R_1 end separately in the costa.

elongated ventrally or narrowed, and posteriorly the ninth sternite strongly curved dorsally. The anal lobe and calypter (alula) are absent as in *Gymnophytomyza*. *Ptochomyza* is considered to be the most highly specialized, since the larvae, mining the small leaves of asparagus, have a number of very divergent modifications that are found nowhere else in the family.

KEYS TO THE GENERA

Adults

1. Subcosta developed throughout its length, coalescing with R_1 before reaching costa; R_1 somewhat broadened at union with costa (fig. 16*a*) (Agromyzinae) 2
   Subcosta becoming a fold distally and ending in costa separately and basad of R_1; R_1 not broadened distally (fig. 16*b*) (Phytomyzinae) 5
2. Halteres black 3
   Halteres white or yellowish .... (1) *Agromyza*
3. Carina between antennae prominent and fusiform or hemispherical 4
   Carina between antennae narrow and flattened .... (2) *Melanagromyza*
4. Orbital setulae erect or dorsally directed; carina fusiform .... (3) *Ophiomyia*
   Orbital setulae anteriorly directed; carina hemispherical .... (4) *Tylomyza*
5. Genovertical plates each not more than one-third width of distance between eyes, completely separated by frontal vitta 6
   Genovertical plates greatly widened anteriorly, meeting centrally dorsad of lunule; frontal vitta acuminate anteriorly (Palearctic region) .... (5) *Selachops*
6. Scutellar setae four 7
   Scutellar setae two .... (7) *Cerodontha*
7. Orbital setulae erect or dorsally directed, sometimes weakly developed or absent 8
   Orbital setulae well developed, anteriorly directed 15
8. Costa reaching apex of R_{4+5}; last segment of M_{3+4} at least twice as long as penultimate section when cross vein m-m present 14
   Costa reaching M_{1+2} rarely R_{4+5} (*Phytobia*), and then last segment of M_{3+4} subequal to penultimate section 9

9. Propleural seta present 10
Propleural seta absent (Palearctic region) .... (15) *Gymnophytomyza*

10. Scutellum yellow, at least centrally; intra-alar seta absent or weakly developed 11
Scutellum concolorous with mesonotum, usually dark; intra-alar seta usually well developed (6) *Phytobia*

11. Postvertical setae present 12
Postvertical setae absent (Palearctic region) .... (10) *Xeniomyza*

12. *Orbital setulae well developed; upper fronto-orbital* setae usually two; lower fronto-orbital setae variable in number; cross vein m-m usually present 13
Orbital setulae sparse, minute; upper fronto-orbital seta single; lower fronto-orbital setae three; cross vein m-m absent .... (11) *Haplomyza*

13. Humeri, pleurae, and head partly yellow; genovertical plates not prominent, narrow (8) *Liriomyza*
Humeri and pleurae completely brown or black and head mostly black; genovertical plates prominent, each about one-third width between eyes (Palearctic region) ... (9) *Metopomyza*

14. Cross vein m-m, when present, never basal to cross vein r-m; basal section of M_{3+4} present (14) *Phytagromyza*
Cross vein m-m basal to cross vein r-m and appearing to be the basal section of vein M_{3+4}, which is absent .... (16) *Pseudonapomyza*

15. Costa reaching apex of M_{1+2} 16
Costa reaching apex of R_{4+5} 17

16. Axillary lobe and calypter well developed; acrostichal setae present, sparse (12) *Phytoliriomyza*
Axillary lobe very small and calypter virtually absent; acrostichal setae absent (Nearctic region) .... (13) *Xyraeomyia*

17. Cross vein m-m absent 18
Cross vein m-m present .... (17) *Napomyza*

18. Notopleural setae two, situated near ventral margin of notopleural triangle. (18) *Phytomyza*
Notopleural seta single, centrally situated .... (19) *Ptochomyza*

Male Terminalia

1. Postgonites in the form of flattened plates, longitudinally elongate and not projecting ventrally, or projecting slightly and then broadly reniform and without teeth (Agromyzinae) . 2
Postgonites vertical, strongly elongate vertically and terminating ventrally with teeth, or smoothly and narrowly rounded (Phytomyzinae) 5

2. Postgonites not folded but broadly elongate longitudinally and not extending ventrally; pregonites separated from ninth sternite by a suture 3
Postgonites folded back and broadly reniform ventrally; pregonites united to ninth sternite (1) *Agromyza*

3. Ninth tergite slightly elongate ventrally; aedeagal hood short, weakly sclerotized and without spines 4
Ninth tergite and surstyli nearly circular when viewed posteriorly; aedeagal hood large, heavily sclerotized and bearing spines dorsally .... (2) *Melanagromyza*

4. Surstyli moderately elongate ventrally and bearing spines ventrally on inner margin (3) *Ophiomyia*
Surstyli strongly elongate ventrally and bearing heavy spines along most of anterior margin (4) *Tylomyza*

5. Phallus with distal portion composed of a pair of tubules or darkly sclerotized curving rods, terminating separately; postgonites with outer process extending to phallophore, the inner process usually very short and always separate; phallophore large, long, extending slightly beyond anterior margin of ninth tergite 6
Phallus with distal portion rarely with a pair of sclerotized tubules—these, if present, united distally; postgonites variable, but with dorsal processes rarely extending to phallophore separately; phallophore seldom large, sometimes slenderly elongate anteriorly 10

6. Ninth tergite incurved only along entire ventral margin, or not incurved, and bearing few spines 7
   Ninth tergite incurved along posteroventral margin and bearing a row of heavy, blunt spines (5) *Selachops*
7. Surstyli attached ventrad of mid-line, not forming elongate flattened plates.... 8
   Surstyli attached dorsad of mid-line, elongate, flattened, extending ventrad of ninth tergite and without spines....(7) *Cerodontha*
8. Surstyli bearing two to many heavy spines, usually separated by a suture....9
   Surstyli bearing only fine setulae, not separated by a suture....(13) *Xyraeomyia*
9. Phallus with distal section composed of a pair of tubules, often sigmaform or twisted; pregonites usually each bearing one to four setae....(6) *Phytobia*
   Phallus with distal section composed of a pair of darkly sclerotized, curving rods; pregonites without setae ....(12) *Phytoliriomyza*
10. Postgonites with outer process usually very short, the inner process extending to phallophore and separate from outer process; surstyli usually with spines or teeth....11
    Postgonites with outer process extending to phallophore and usually united or approximate with inner process or inner process separate and usually not extending more than halfway to phallophore; surstyli with setae only....14
11. Surstyli separated from ninth tergite by a suture....12
    Surstyli not separated from ninth tergite by a suture....(10) *Xeniomyza*
12. Ninth sternite with sidepieces slender; pregonites without setae....13
    Ninth sternite with sidepieces thickened; pregonites each bearing a single seta (11) *Haplomyza*
13. Surstyli borne on ventral margin of ninth tergite....(8) *Liriomyza*
    Surstyli borne halfway between ventral margin of ninth tergite and the attachment to the ninth sternite ....(9) *Metopomyza*
14. Ninth sternite with sidepieces slender, elongate anteriorly....15
    Ninth sternite with sidepieces somewhat thickened and broadened, relatively short....16
15. Postgonites each terminating ventrally in a single large tooth; phallus with distal section membranous, short, and slender....(15) *Gymnophytomyza*
    Postgonites each terminating ventrally in two or three blunt teeth; phallus with distal section heavily and darkly sclerotized, long, and moderately broad....(16) *Pseudonapomyza*
16. Postgonites with inner and outer dorsal processes united, or separate with both processes extending slenderly to the phallophore....17
    Postgonites with inner and outer dorsal processes separate, the inner process short and broad, reaching about halfway to the phallophore....(17) *Napomyza*
17. Postgonites slightly or moderately expanded ventrally, usually narrowing before termination 18
    Postgonites greatly broadened ventrally, terminating broadly and with margin irregular (19) *Ptochomyza*
18. Postgonites each with inner and outer dorsal processes extending separately to phallophore (14) *Phytagromyza*
    Postgonites each with inner and outer dorsal processes united or approximate. (18) *Phytomyza*

North American Larvae

1. Paraclypeal phragma broadened dorsally, the heavily sclerotized dorsal and ventral arms either visibly meeting or approximate posteriorly (fig. 10) (Agromyzinae)....2
   Paraclypeal phragma relatively narrow, the dorsal arm well developed, the ventral arm usually absent, rarely elongate and then very slender (fig. 14) (Phytomyzinae)....5
2. Mandibles very unequal in size; if subequal, each with a single large tooth....3
   Mandibles subequal in size, each with two well-developed teeth....(1) *Agromyza*
3. Ventral arm of dorsal process originating posteriorly, apparently from dorsal arm; mandibles each usually with two well-developed teeth....4
   Ventral arm of dorsal process not originating posterior to dorsal arm; mandibles short and compact, each with a single large tooth....(2) *Melanagromyza*

4. Mandibles each with two well-developed teeth............................(3) *Ophiomyia*
Mandibles each with one well-developed terminal tooth, the other tooth very small
(4) *Tylomyza*

5. Mandibles subrectangular, usually slender; neither anterior nor posterior spiracles palmately lobed 6
Mandibles broadly triangular with base very broad; both anterior and posterior spiracles large, each palmately lobed..(7) *Cerodontha*

6. Mandibles not produced ventrally and not acuminate.................................7
Mandibles produced ventrally, acuminate..........................(12) *Phytoliriomyza*

7. Anterior spiracles variable, sometimes bilobed, never elongate or flattened; posterior spiracles with variable number of bulbs, but if three, none more than twice as long as the others...8
Anterior spiracles without lobes, but sometimes elongate or flattened; posterior spiracles usually with three bulbs and one bulb elongate, hook-shaped, or twisted, rarely with many bulbs ....(6) *Phytobia*

8. Posterior spiracles small, knoblike, or with many bulbs and often complex; mandibles with teeth usually subequal in size; whitish...9
Posterior spiracles with three bulbs, one often twice as long as the other two, or with numerous bulbs and sometimes bilobed; mandibles each with terminal tooth the stronger, but median well developed; usually yellow on anterior half of body..................(8) *Liriomyza*

9. Right mandible with teeth evenly alternating with those of left mandible; posterior spiracles usually with numerous bulbs..10
Right mandible with terminal tooth distant from other, the median tooth of right mandible and terminal tooth of left mandible opposite or nearly so; posterior spiracles small, each with six to eight bulbs...(11) *Haplomyza*

10. Body segments each without a row of elongate spines...............................11
Body segments each bearing a row of elongate spines that continue around the segment
(16) *Pseudonapomyza*

11. Anterior spiracles with two large, equal lobes; no prothoracic process dorsad of antennae; paraclypeal phragma with ventral arm of dorsal process usually absent, if present then very slender, straight ....(14) *Phytagromyza*
Anterior spiracles with one or two small lobes; a prothoracic process dorsad of antennae sometimes present; paraclypeal phragma with ventral arm absent
(17) *Napomyza* and (18) *Phytomyza*

Subfamily AGROMYZINAE Fallén

Agromyzides Fallén, 1823, Dipt. Suec., Agromyzid., 2 (37):1; Zetterstedt, 1840, Insecta Lapponica, Dipt., 3 (5):783; Zetterstedt, 1848, Dipt. Scand., 7:2681; Zetterstedt, 1860, Dipt. Scand., 14:6445.

Agromyzina Rondani, 1856, Dipt. Ital. Prod., 1:120.

Agromyzidae Loew, 1862, Smithson. Misc. Coll., 1:46; Osten Sacken, 1878, Smithson. Misc. Coll., 16:209; Williston, 1888, Synop. and Gen. N. A. Dipt., p. 64; Collin, 1911, Ent. Mon. Mag., 22:253.

Agromyzini Lioy, 1864, Atti Ist. Veneto, (3) 9:1312.

Agromyzinae Rondani, 1875, Boll. Soc. Ent. Ital., 7:166; Williston, 1896, Manual N. A. Dipt., 2d ed., p. 104; Aldrich, 1905, Smithson. Misc. Coll., 46:647; Malloch, 1913, Proc. U. S. Nat. Mus., 46:129; Frey, 1921, Acta Soc. Faun. Flor. Fenn., 48:217.

Type.—Agromyza Fallén, 1810.

Adult.—Wing with subcosta complete, coalescing with R_1 immediately before reaching costa, the costa indented at that point, R_1 somewhat broadened at costal union, approximate with costa for a short distance beyond break (fig. 16, *a*); mouthparts with galea elongate and without premental basal projections; male terminalia with postgonites consisting of broad, flattened plates, elongate longitudinally, never vertical, not projecting ventrally, or projecting slightly and then broadly reniform and without teeth; wings, when at rest, only partly folded over dorsum of abdomen, never folded completely, one above the other.

Larva.—Paraclypeal phragma of cephalopharyngeal apparatus broadened dorsally; heavily sclerotized dorsal and ventral arms either visibly meeting or approximate posteriorly (fig. 10).

Fallén (1823*a*) included three genera in the Agromyzides: *Heteroneura* (Clusiidae), *Agromyza,* and *Anthomyza* Fallén (Anthomyzidae). This group was separated from Phytomyzides primarily on the position of cross vein m-m, which is at or near the middle of the wing. Zetterstedt greatly broadened the concept and included ten genera (1840), twelve genera (1848), and thirteen genera (1860). *Anthomyza* was removed by Zetterstedt, whereas *Heteroneura* and *Chlorops* of Panzer (for *denticornis*) were included throughout; *Selachops* Wahlberg was added in 1848.

The stirps Agromyzina was erected by Rondani (1856) to include Agromyzides and parts of the Geomyzides, Heteromyzides, and Phytomyzides. This concept was not characterized, but the following genera were placed in it: *Milichia* Meigen (Milichiidae), *Alticomerus* Rondani (Odiniidae), *Therina* Meigen (? family), *Domomyza,* n. gen., *Agromyza,* and *Chyromyia* Robineau-Desvoidy (Chyromyidae). The stirps Oscinina Rondani contained eight diverse genera including *Odontocera* Macquart (now *Cerodontha* Rondani).

Loew (1862) recognized the family Agromyzidae on the basis of the position of cross vein m-m, which is distant from the border of the wing. Loew mentioned three North American genera, *Agromyza, Lobioptera* Wahlberg (Milichiidae), and *Milichia* Meigen, as belonging within the family.

Osten Sacken (1878) included under Agromyzidae, along with *Agromyza* and *Odontocera,* such genera as *Rhicnoëssa* Loew (Geomyzidae), *Milichia* Meigen, *Pholeomyza* Bilimek, *Desmometopa* Loew, *Cacoxenus* Loew, *Phyllomyza* Fallén, *Lobioptera* Wahlberg (Milichiidae), *Aulacigaster* Macquart (Aulacigasteridae), and *Ochthiphila* Fallén (Ochthiphilidae).

Lioy (1864) separated the subfamily Agromyzini on the basis of the presence and position of cross vein m-m. He included a number of diverse genera that have subsequently been placed in the families Milichiidae and Carnidae. The [illegible]romyzid genera included *Agromyza, Mesoncvra,* n. gen. (synonymous with *Ag[illegible]yza*), *Phytobia,* n. gen., *Redia,* n. gen. (synonymous with *Phytobia*), *Cerodont[illegible]* and *Agrophila,* n. gen. (synonymous with *Liriomyza*).

Rondani (1875) included in Agromyzinae the species having wings with six longitudinal veins and the first vein (Sc) either interrupted or united with the second (R_1) before or near the costa. The group was divided according to the size of the costal break at the apex of Sc, this being large in *Milichia* Meigen, *Lobioptera* Wahlberg (Milichiidae), and *Canace* Haliday (Canaceidae), and small in *Odinia* Robineau-Desvoidy (Odiniidae), *Therina* Meigen (? family), *Anthophilina* Zetterstedt (synonym of *Anthomyza*), *Cryptochetum,* n. gen. (Cryptochetidae), *Selachops, Agromyza,* and *Domomyza* Rondani.

Williston (1896*b*) considered agromyzids as belonging to the subfamily Agromyzinae if cross vein m-m is situated before the middle of the wing and if cross vein r-m is present, so that the second basal cell (M) is shorter than the first basal cell (R).

Malloch (1913*b*) characterized the Agromyzinae as having the pvt setae divergent and crossvein m-m situated distad of crossvein r-m. Four genera were included by Malloch: *Traginops* Coquillett, *Odinia* Robineau-Desvoidy (Odiniidae), *Cerodontha,* and *Agromyza* s.l.

Frey (1921) divided the family Agromyzidae on the basis of differences in the mouthparts. Flies with the galea elongate and without premental basal projections were placed in the Agromyzinae, and those with rudimentary galea and with premental basal projections were placed in Phytomyzinae. My study of the mouthparts of some species of *Agromyza* and *Melanagromyza* has shown these characters to be of diagnostic value.

Differences in the subcosta and its termination in the costa were first mentioned by Rondani (1875). The significance of this character was not realized until Hendel (1920) used it to separate the genera into two groups. The differences in the cephalopharyngeal apparatus of the larvae were first described by de Meijere (1925). Hendel (1931*a*) correlated the larval and adult wing characters and divided the family into two groups. His concepts are considered here as of subfamily significance.

1. Genus *Agromyza* Fallén

[Gr., *agros*, field; plus *myzon*, sucker]

Agromyza Fallén, 1810, Nov. Dipt. Dispon. Method., p. 21, no. 66; Fallén, 1823, Dipt. Suec., Agromyzid., 2 (37):3; Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:166; Macquart, 1835, Hist. Nat. Insect., Dipt., 2:605; Westwood, 1840, Introd. Classif. Insects, Gen. Syn., 2:151; Zetterstedt, 1848, Dipt. Scand., 7:2728; Rondani, 1856, Dipt. Ital. Prod., 1:121; Walker, 1853, Insecta Brit., Dipt., 2:241; Zetterstedt, 1860, Dipt. Scand., 14:6449; Lioy, 1864, Atti Ist. Veneto, (3) 9:1312; Schiner, 1864, Fauna Austr., Flieg., 2:298; Rondani, 1875, Boll. Soc. Ent. Ital., 7:177; Aldrich, 1905, Smithson. Misc. Coll., 46:647; Becker *et al.*, 1905, Kat. palaearkt. Dipt., 4:241; Coquillett, 1910, Proc. U. S. Nat. Mus., 37:504; Melander, 1913, Jour. N. Y. Ent. Soc., 21:251; Malloch, 1913, Ann. Ent. Soc. Amer., 6:270; Hendel, 1920, Arch. Naturgesch., Abt. A., 84:117; Frost, 1924, Cornell Mem., 78:38; de Meijere, 1925, Tijdschr. Ent., 68:214; Hering, 1927, Tierw. Deutschl., 6:9; Hendel, 1927, Zool. Anz., 69:249; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:93; Hendel, 1936, *in* Lindner: Die Flieg. palaearkt. Reg., 59:569; Kloet and Hincks, 1945, Check List Brit. Insects, p. 402.

Domomyza Rondani, 1856, Dipt. Ital. Prod., 1:121; Rondani, 1875, Boll. Soc. Ent. Ital., 7:168, 172; Becker *et al.*, 1905, Kat. palaearkt. Dipt., 4:249; Collin, 1911, Ent. Mon. Mag., 22:253; Hendel, 1920, Arch. Naturgesch., Abt. A., 84:123; de Meijere, 1925, Tijdschr. Ent., 68:235; Hering, 1927, Tierw. Deutschl., 6:27; Enderlein, 1936, Tierw. Mitteleur., 6 (3):178, 181; Kloet and Hincks, 1945, Check List Brit. Insects, p. 402.

Mesonevra Lioy, 1864, Atti Ist. Veneto, (3) 9:1312. New synonymy.

Stomacryoplus Enderlein, 1936, Tierw. Mitteleur., 6 (3):178, 181; Enderlein, 1936, Mitt. dtsch. ent. Ges., 7:42.

Type.—Agromyza nigripes Meigen, 1830, by subsequent designation of Westwood, 1840.

Types of synonyms.—Domomyza: Domomyza cincta Rondani, 1856 (*nom. nud.*), monobasic; *Agromyza ambigua* Fallén, 1823, by subsequent designation of Rondani, 1875 (as *A. nigripes* Meigen, 1830); *Mesonevra: Agromyza mobilis* Meigen, 1830, monobasic; *Stomacryoplus: Agromyza ambigua* Fallén, 1823, by subsequent designation of Enderlein, 1936*b*.

Adult.—Moderately large to large, robust, 2 to 4.5 mm. in body length. Usually black or brown, rarely metallic or shining, rarely extensively yellow; halteres white or yellowish.

Head: Mesofacial plate with a low, narrow median carina; frontal lunule small, dorsally not turned inward, ptilinal fissure small, not forming a deep groove across front. Third antennal segment of variable shape, usually more or less rounded at apex, rarely slightly attenuated on outer dorsal angle, but never forming an acute angle. Proboscis short. Setae: 1 to 4 ifo, usually 2; 2 sfo; os erect or dorsally directed.

Setal pattern of thorax: 1h; 1 prs; 1 sa; 1 ia; 2 pa; rarely 3 + 0 or 2 + 1, usually 3 + 1 or 4 + 1 dc; acr numerous, in about 8 regular rows, extending posteriorly to prsc; 1 prsc; 1 pp; 2 npl; 1 aes; 1 kes.

Wing (fig. 17*): Costa reaching R_{4+5} or, more often, M_{1+2}; m-m present (sometimes absent on one or both wings in 2 European species), rarely less than its length beyond r-m, usually well removed.

Male terminalia: Aedeagal apodeme posteriorly terminating anterior to ninth tergite; epiphallus moderately long; aedeagal hood very elongate, ventrally produced before turning dorsally, attached laterally to postgonites. Phallophore very closely united to aedeagal apodeme, strongly produced anteriorly; portion bearing phallus moderately long, tubular. Phallus large, long; basal section long, 2 sclerites distinct, with ventral processes moderately long, one sometimes membranous; median section very short, both sclerites distinct, distal processes short, broadened; distal section tubular, moderately long, somewhat dorsally curved, distal paired openings surrounded by a protective sheath. Ninth sternite curved vertically, sidepieces somewhat broadened; arms to bacilliform sclerites very slightly curved dorsally, not lengthened posteriorly; hypandrial apodeme moderately elongate, subtriangular or with sides parallel. Pregonites broadly united to ninth sternite; extending nearly to mid-line and turned dorsally; bearing a few sensory pores and numerous very fine setulae. Postgonites reniform ventrad of ninth sternite, doubling back to attach to pregonites; connected to phallophore anteriorly by the long, curved, slender inner process; outer process short. Ninth tergite articulated to ninth sternite ventrally; not receding dorsad or ventrad of point of attachment; broader than high. Surstyli not separated by a suture; turned strongly inward; with numerous short, heavy spines, on inward surface only; broadly united with bacilliform sclerites. Bacilliform sclerites united for full length by a membrane, occupying most of interior of ninth tergite. Cerci large; elongate, flattened, not broadened centrally. Ejaculatory apodeme large; base moderately elongate, stem without lateral projections; blade slightly to greatly broadened. Bulb rather elongate.

Larva.—Usually large, robust, up to 5 mm. in length. White to grayish white.

Head: Mandibles each with 2 strong teeth, usually subequal in size; teeth not alternating with each other when viewed laterally. Paraclypeal phragma with dorsal process greatly broadened; dorsal and ventral arms approximate posteriorly; ventral process moderately short. Head processes usually absent, but when present they are short and filiform.

Body: Anterior spiracles usually knoblike, sometimes 2-lobed; bulbs not numerous. Abdominal cuticular processes well developed, in irregular rows; largest centrally; rounded or pointed; usually posteriorly directed. Posterior spiracles not large, usually with 3 openings; rarely provided with setulae. Posterior end usually rounded; sometimes with a few small rounded tubercles in anal area, which extend dorsally to posterior spiracles; anal lobes absent.

The species *Agromyza nigripes* Meigen and *A. ambigua* Fallén have long been considered identical. Zetterstedt (1848) was the first to synonymize *A. ambigua* with *A. nigripes;* he was followed in this by Walker (1853), Schiner (1864), Rondani (1875), and Strobl (1894). Malloch (1913*a*) noted that the *A. nigripes* of Zetterstedt required a new name and proposed *A. subnigripes.* Hendel (1931*b*) found that *A. nigripes* of Zetterstedt was actually *A. mobilis* Meigen, 1830, and that *A. subnigripes* Malloch was a synonym. In *A ambigua* Fallén and *A. mobilis* Meigen the costa reaches R_{4+5}, whereas in *A. nigripes* Meigen it reaches M_{1+2}. It is to be presumed that Westwood (1840) had the *A. nigripes* of Meigen, because the misidentification was made after 1840.

Rondani (1875) designated *Agromyza reptans* Fallén as the type of *Agromyza,* and Hendel (1920, 1931*b*) followed him in this. *Domomyza cincta* Rondani (1856) has never been adequately described, and no specimens are known to exist. Hendel (1936) tentatively placed it near *Phytagromyza flavocingulata* (Strobl), 1909. Terminalia studies have confirmed that *A. ambigua* belongs to the genus *Agromyza,* and they place both *Domomyza* Rondani and *Stomacryoplus* Enderlein as synonyms of *Agromyza. Mesonevra* was erected by Lioy (1864) for *A. mobilis* Meigen, on the basis of the position of cross vein m-m, which is at the middle of the wing.

* Figs. 17–34, illustrating wings, will be found on pp. 450–452.

The genus *Agromyza* was redefined by Hendel (1920), and several new genera were erected to accommodate the heterogeneous groups previously lumped under *Agromyza.* Hendel (1931*b*) listed sixty Palearctic species, and only five have been described since that time. North American species have been described in *Agromyza* s.l. that can now be placed in *Melanagromyza, Ophiomyia, Tylomyza, Phytobia, Liriomyza, Phytoliriomyza, Phytagromyza,* and *Napomyza.*

NEW WORLD SPECIES IN THE GENUS AGROMYZA

Agromyza albidohalterata Malloch

Agromyza albidohalterata Malloch, 1916, Psyche, 23:52.

Illinois.

Agromyza albitarsis Meigen

Agromyza albitarsis Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:171; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:100; Hering, 1932, Zeitschr. PflKrankheit., 42:579; de Meijere, 1934, Tijdschr. Ent., 77:247.

Agromyza flavicornis Zetterstedt, 1855, Dipt. Scand., 12:4812.

Agromyza mobilis Brischke, 1881 (*nec* Meigen, 1830), Schrift. Naturf. Ges. Danzig, 5:49.

Agromyza populi Hendel, 1920, Arch. Naturgesch., Abt. A., 84:170.

Dr. Hering recently confirmed that this species occurs in North America. The larvae form blotch mines in leaves of *Populus* sp. in Europe. I have reared this species from *Populus trichocarpa* T. & G., *P. nigra* var. *italica*, and *Salix lasiandra* Benth.; this last host plant formed a new genus record. Europe, California.

Agromyza ambigua Fallén

Agromyza ambigua Fallén, 1823, Dipt. Suec., Agromyzid., 2 (37):4; Hendel, 1920, Arch. Naturgesch., Abt. A., 84:124; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:103.

Agromyza nigripes Zetterstedt, p.p., 1848 (*nec* Meigen, 1830), Dipt. Scand., 7:2738.

Agromyza neptis Coquillett, 1900, (*nec* Loew, 1869), Proc. Wash. Acad. Sci., 2:463.

Agromyza cinerascens Melander, 1913 (*nec* Macquart, 1835), Jour. N. Y. Ent. Soc., 21:253.

Agromyza kincaidi Malloch, 1913, Ann. Ent. Soc. Amer., 6:285.

Domomyza nigrella Rondani, 1875, Boll. Soc. Ent. Ital., 7:176.

Malloch synonymized *A. neptis* of Coquillett with *A. kincaidi*, and Hendel synonymized the remaining species. The larvae mine in the leaves of grasses. Europe, North Africa, North America.

Agromyza aprilina Malloch

Agromyza aprilina Malloch, 1915, Bull. Ill. Lab., 11:359.

Illinois.

Agromyza barberi Frick, new name

Agromyza abbreviata Malloch, 1913 (*nec* Fallén, 1823), Ann. Ent. Soc. Amer., 6:285. Primary homonym.

The type was collected by Dr. H. S. Barber, and the species is named in his honor. New Mexico.

Agromyza calyptrata Hendel

Agromyza nigrisquama Malloch, 1916 (*nec* Malloch, 1914), Psyche, 23:53. Primary homonym.

Agromyza calyptrata Hendel, 1923 (n.n. for *A. nigrisquama* Malloch, 1916, *nec* Malloch, 1914), Konowia, 2:145.

Illinois.

Agromyza canadensis Malloch

Agromyza canadensis Malloch, 1913, Ann. Ent. Soc. Amer., 6:299.

Canada.

Agromyza centrosemae Frost

Agromyza centrosemaė Frost, 1936, Ann. Ent. Soc. Amer., 29:301.

The larvae mine the leaves of *Centrosema pubescens* Benth. Canal Zone.

Agromyza currani Frost

Agromyza currani Frost, 1936, Ann. Ent. Soc. Amer., 29:305.

Closely related to *A. parvicornis* Loew. Canal Zone.

Agromyza dorsocentralis Frost

Agromyza dorsocentralis Frost, 1936, Ann. Ent. Soc. Amer., 29:307.

Canal Zone.

Agromyza dubitata Malloch

Agromyza dubitata Malloch, 1913, Ann. Ent. Soc. Amer., 6:311.

A male of this species in the California Academy of Sciences collection, identified by Malloch, has 3 + 2 dc setae. The fourth dc is half the length of the third, and the fifth about half the fourth and about twice an acr seta in length. Canada, Massachusetts, California.

Agromyza frosti Frick, new name

Agromyza schmidti Frost, 1936 (*nec* Aldrich, 1929), Ann. Ent. Soc. Amer., 29:302. Primary homonym.

The larvae form woolly galls on the stems of an unidentified plant. Costa Rica.

Agromyza inaequalis Malloch

Agromyza inaequalis Malloch, 1914, Proc. Ent. Soc. Wash., 16:89; Frost, 1931, Ent. News, 42:75.

Reared from *Vigna repens*. Puerto Rico.

Agromyza iridescens Frost

Agromyza iridescens Frost, 1936, Ann. Ent. Soc. Amer., 29:303.

Closely related to *A. viridula* Coquillett. Canal Zone.

Agromyza isolata Malloch

Agromyza isolata Malloch, 1913, Ann. Ent. Soc. Amer., 6:306.

California.

Agromyza mobilis Meigen

Agromyza mobilis Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:169; Hendel, 1920, Arch. Naturgesch., Abt. A., 84:124; Venturi, 1936, Boll. Ist. Ent., 9:1.

Agromyza nigripes Zetterstedt, 1848 (*nec* Meigen, 1830), Dipt. Scand., 7:2738; Melander, 1913, Jour. N. Y. Ent. Soc., 21:254.

Agromyza subnigripes Malloch, 1913 (n.n. for *A. nigripes* Zetterstedt, 1848, *nec* Meigen, 1830), Ann. Ent. Soc. Amer., 6:334.

Domomyza anthracipes Rondani, 1875, Boll. Soc. Ent. Ital., 7:176.

Melander has specimens of *A. nigripes* of Zetterstedt obtained from Strobl. The larvae mine in the leaves of grasses. Europe, Colorado.

Agromyza neptis Loew

Agromyza neptis Loew, 1869, Berl. ent. Zeitschr., 13:50; Melander, 1913, Jour. N. Y. Ent. Soc., 21:254; Malloch, 1913, Ann. Ent. Soc. Amer., 6:309.

Widespread in North America.

Agromyza nitida Malloch

Agromyza nitida Malloch, 1913, Ann. Ent. Soc. Amer., 6:288.

Maryland.

Agromyza parvicornis Loew

Agromyza parvicornis Loew, 1869, Berl. ent. Zeitschr., 13:49; Malloch, 1913, Ann. Ent. Soc. Amer., 6:312; Frost, 1924, Cornell Mem., 78:48; Lange, 1949, Pan-Pac. Ent., 25:91.

The larvae of this species, the corn blotch leaf miner, mine in the leaves of *Zea mays* L. Long considered an eastern North American species, it was reported by Lange (1949) from California, and I reared it in the Yakima Valley, Washington, in 1949.

Agromyza reptans Fallén

Agromyza reptans Fallén, 1823, Dipt. Suec., Agromyzid., 2 (37):3; Melander, 1913, Jour. N. Y. Ent. Soc., 21:253, 254.

The larvae mine the leaves of species in the family Urticaceae. I reared the species from leaf mines on *Urtica californica* Greene, in Berkeley, California, in 1948. Melander (1913) previously recorded the species from Oregon and Washington. Europe and western North America.

Agromyza setosa Loew

Agromyza setosa Loew, 1869, Berl. ent. Zeitschr., 13:45.

Two specimens from San Diego, California, dated 3-29-1891, determined by Malloch, are in the California Academy of Sciences collection. Found throughout the United States.

Agromyza spiraeae Kaltenbach

Agromyza spiraeae Kaltenbach, 1867, Verh. naturh. Ver. preuss. Rheinl. und Westphal., 24:104; Hendel, 1920, Arch. Naturgesch., Abt. A., 84:122.

Agromyza potentillae (Kaltenbach), 1864, Verh. naturh. Ver. preuss. Rheinl. und Westphal., 21:351 (as *Phytomyza*).

Agromyza carbonaria Brischke, 1881 (*nec* Zetterstedt, 1848), Schrift. Naturf. Ges. Danzig, 5:17, 19.

Agromyza fragariae Malloch, 1913, Ann. Ent. Soc. Amer., 6:307.

Hendel synonymized all the above-listed species. The larvae mine in the leaves of plants in the family Rosaceae, particularly *Spiraea* sp. *A. fragariae* has been recorded from leaf mines on strawberry, blackberry, and raspberry. Europe, and widespread in the United States.

Agromyza sulphuriceps Strobl

Agromyza sulphuriceps Strobl, 1898, Mitt. Naturwiss. Ver. Steier., 34:270; Melander, 1913, Jour. N. Y. Ent. Soc., 21:255, 268; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:152.

Agromyza xanthocephala Strobl, 1894 (*nec* Zetterstedt, 1860), Mitt. Naturwiss. Ver. Steier., 30:139.

Agromyza rubi Hendel, 1920 (*nec* Brischke, 1881), Arch. Naturgesch., Abt. A., 84:120.

Agromyza montana Hendel, 1920, Arch. Naturgesch., Abt. A., 84:123.

Melander has one specimen from Strobl and seven from Washington and Idaho. I have one from California that agrees with those in Melander's collection as well as with two specimens sent by Dr. Hering. The larvae mine the leaves of *Sanguisorba officinalis* L. and *Potentilla erecta* L. in Europe. Central Europe, western North America.

Agromyza varifrons Coquillett

Agromyza varifrons Coquillett, 1902, Jour. N. Y. Ent. Soc., 10:189; Malloch, 1913, Ann. Ent. Soc. Amer., 6:292; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:154.

Hendel (1931*c*) placed this species and Melander's specimens of *A. sulphuriceps* as synonyms of *A. trebinjensis* Strobl, 1900. The description given by Hendel does not seem to include either species. Washington, D.C., and Pennsylvania.

Agromyza viridula Coquillett

Agromyza viridula Coquillett, 1902, Jour. N. Y. Ent. Soc., 10:189; Frost, 1924, Cornell Mem., 78:55.

Reared from mines in the leaves of red oak. Eastern United States.

Unplaced New World Species Originally Described in Agromyza

Agromyza anthrax Williston

Agromyza anthrax Williston, 1896, Trans. Ent. Soc. London, 1896: 430; Melander, 1913, Jour. N. Y. Ent. Soc., 21:254; Malloch, 1913, Ann. Ent. Soc. Amer., 6:329.

St. Vincent in British West Indies.

Agromyza auriceps Melander

Agromyza auriceps Melander, 1913, Jour. N. Y. Ent. Soc., 21:262.

Idaho, Colorado.

Agromyza biformata Becker

Agromyza biformata Becker, 1919, Mis. Arc Mérid. Amér. Sud., 10:213.

Ecuador.

Agromyza bipartita Becker

Agromyza bipartita Becker, 1919, Mis. Arc Mérid. Amér. Sud., 10:213.

Ecuador.

Agromyza guaranitica Brèthes

Agromyza guaranitica Brèthes, 1920, An. Soc. Rur. Argent., 54:283; Costa Lima, 1936, Ter. Cat. Insect. Brasil., p. 371.

This species has 2 + 0 dc setae, a black spot on the knob of the halteres; the larvae mine the leaves of chrysanthemum. Argentina, Brazil.

Agromyza illinoensis Malloch, *nomen nudem*

Agromyza illinoensis Malloch, 1934, Dipt. Patag. S. Chile, 6:483.

There is no previous record, in the literature, of this species, although Malloch mentions it as being North American, and states that it possesses only two sc setae. The European species with which he compared *A. illinoensis* was originally described in *Dizygomyza* and has subsequently been placed in *Cerodontha*.

Agromyza indecora Malloch

Agromyza indecora Malloch, 1918, Canad. Ent., 50:132.

The costa reaches slightly distad of the apex of R_{4+5}. Illinois.

Agromyza innominata Williston

Agromyza innominata Williston, 1896, Trans. Ent. Soc. London, 1896:443; Melander, 1913, Jour. N. Y. Ent. Soc., 21:257; Malloch, 1913, Ann. Ent. Soc. Amer., 6:329.

The large palpi shown in Williston's figure (fig. 158) cause me to concur with Malloch that the species does not belong in the family Agromyzidae. St. Vincent in British West Indies.

Agromyza invaria Walker

Agromyza invaria Walker, 1857, Trans. Ent. Soc. London, 4:232; Melander, 1913, Jour. N. Y. Ent. Soc., 21:267.

The description is inadequate to place the species. United States.

Agromyza pallidiseta Malloch

Agromyza pallidiseta Malloch, 1924, Canad. Ent., 56:192.

Peculiar in having all setae yellowish. Washington, D.C.

Agromyza pleuralis Malloch

Agromyza pleuralis Malloch, 1914, Ent. News, 25:311.

Illinois.

Agromyza pollinosa Melander

Agromyza pollinosa Melander, 1913, Jour. N. Y. Ent. Soc., 21:263.

Alaska.

Agromyza reverberata Malloch

Agromyza reverberata Malloch, 1924, Canad. Ent., 56:191.

Maryland.

Agromyza rutiliceps Melander

Agromyza rutiliceps Melander, 1913, Jour. N. Y. Ent. Soc., 21:261.

Montana.

Agromyza subinfumata Malloch

Agromyza infumata Malloch, 1915 (*nec* Czerny and Strobl, 1909). Canad. Ent., 47:15. Primary homonym.

Agromyza subinfumata Malloch, 1915 (n.n. for *A. infumata* Malloch, 1915, *nec* Czerny and Strobl, 1909), Proc. U. S. Nat. Mus., 49:108.

Agromyza fumosa Hendel, 1923 (n.n. for *A. infumata* Malloch, 1915, *nec* Czerny and Strobl, 1909), Konowia, 2:145.

Illinois.

Agromyza terebrans Bezzi and Tavares

Agromyza terebrans Bezzi and Tavares, 1916, Broteria, Zool., 14:166; Costa Lima, 1936, Ter. Cat. Insect. Brasil., p. 371.

The larvae produce galls on the leaves of *Clitoria cajanifolia*. Brazil.

Agromyza ulmi Frost

Agromyza ulmi Frost, 1924, Cornell Mem., 78:54.

The larvae mine the leaves of elm. New York, Pennsylvania.

2. Genus *Melanagromyza* Hendel

[Gr., *melas*, black; plus *agromyza*]

Melanagromyza Hendel, 1920, Arch. Naturgesch., Abt. A., 84:126; Hendel, 1923, Konowia, 2:142; de Meijere, 1925, Tijdschr. Ent., 68:241; Hering, 1927, Tierw. Deutschl., 6:31: Malloch, 1927, Proc. Linn. Soc. N.S.W., 52:421; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:156;

Malloch, 1935, Bull. Bishop Mus., 114:18; Hendel, 1936, *in* Lindner: Die Flieg. palaearkt. *Reg.*, *59:569; de* Meijere, 1940, Tijdschr. Ent., 83:164; Kloet and Hincks, 1945, Check List *Brit. Insects, p. 401.*

Limnoagromyza Malloch, 1920, Bull. Brooklyn Ent Soc., 15:147.

Solenomyza Enderlein, 1936, Tierw. Mitteleur., 6 (3):179.

Aulomyza Enderlein, 1936, Tierw. Mitteleur., 6 (3):179.

Triopisopa Enderlein, 1936, Tierw. Mitteleur., 6 (3):179; Enderlein, 1936, Mitt. dtsch. ent. Ges., 7:42.

Hexomyza Enderlein, 1936, Tierw. Mitteleur., 6 (3):179; Enderlein, 1936, Mitt. dtsch. ent. Ges., 7:42.

Type.—Agromyza aeneiventris Fallén, 1823, by original designation.

Types of synonyms.—Limnoagromyza: Limnoagromyza dianthereae Malloch, 1920, monobasic; *Solenomyza: Melanagromyza rostrata* Hendel, 1920, monobasic; *Aulomyza: Melanagromyza longilingua* Hendel, 1920, monobasic; *Triopisopa: Agromyza simplex* Loew, 1869, by subsequent designation of Enderlein, 1936*b*; *Hexomyza: Melanagromyza sarothamni* Hendel, 1923, by subsequent designation of Enderlein, 1936*b*.

Adult.—Moderately large to large, robust, 1.5 to 4 mm. in body length. Shining black, sometimes with brilliant greenish metallic sheen; halteres black; calypters white, sometimes fringed with black.

Head: Mesofacial plate with a very low, narrow, flattened median carina; frontal lunule very large, broad, extending one-third to one-half distance to ocellar triangle; ptilinal fissure deeply situated, forming a broad, deep groove across front between genovertical plates. Vertical triangle large, not conspicuous, usually extending anteriorly almost to where frontal vitta turns inward to meet ptilinal fissure; ocellar triangle normal. Antennae not diverging from each other; third segment rounded, broader than long. Proboscis short, or mediproboscis and labella elongate. Setae: vi moderately developed, at times little longer than setae of subcranial margin; 2 or 3 ifo; 2 sfo; os usually erect or dorsally directed, sometimes both erect and anteriorly directed, rarely all anteriorly directed.

Setal pattern of thorax: 1 h; 1 prs; 1 sa; 1 ia; 2 pa, inner very weakly developed, often not differentiated from setulae; usually 2 + 0 or, rarely, 3 + 0 dc; 0 or 1 prsc; 6 to 8 rows of acr, which usually extend posteriorly to scutellum; 1 pp; 2 npl; 1 aes; 1 kes.

Wing (fig. 18): Costa usually reaching M_{1+2}, sometimes reaching only to R_{4+5}, rarely to between R_{4+5} and M_{1+2}; m-m present, often less than its own length from r-m.

Male terminalia: Aedeagal apodeme extending posteriorly far within ninth tergite; epiphallus small, coming to a point distally, attached to aedeagal hood by a clear membrane; aedeagal hood very broad and heavily sclerotized, bearing strong spines dorsally. Phallophore broadly united with aedeagal hood and not intimately associated with aedeagal apodeme; portion bearing phallus short, tubular. Phallus not elongate, sclerotized only on basal half; basal section composed of a very short pair of sclerites broadly united dorsally and somewhat drawn out ventrally; median section moderately sclerotized, doubled back dorsally to form a thickened complex with a pair of long, slender, inconspicuous ventral processes; distal section entirely membranous, moderately long and thickened. Ninth sternite subtriangular, sidepieces extremely broadened and with irregular margins; hypandrial apodeme absent, or represented by a thickening at anterior end; in lateral view, very little to strong vertical curvature, rising somewhat posteriorly to attach to bacilliform sclerites. Pregonites usually widely separated from ninth sternite; subtriangular to rectangular flattened plates bearing sensory pores. Postgonites very broadly united to phallophore by membrane, anteriorly attached to pregonites, from which arises the sclerotized, dorsally directed outer process; not projecting ventrally, being flattened; on ventral and lateral surfaces bearing some very short, blunt protuberances. Ninth tergite nearly circular; articulated to ninth sternite somewhat ventrally; moderately receding dorsad and slightly ventrad of point of attachment. Surstyli not separated by a suture; strongly incurved, approximate centrally; bearing numerous rather long, sharp spines; broadly united to bacilliform sclerites by very wide, heavily sclerotized inner projections which are approximate dorsad of large aedeagal hood. Bacilliform sclerites small, inconspicuous, narrowly united behind broad inner framework of surstyli. Cerci moderately elongate; not reaching ventral margin of ninth tergite, moderately flattened, not

broadened centrally. Ejaculatory apodeme rather large; base curving round and partly encircling bulb, strongly broadened opposite plane of blade; stem bearing 1 or 2 rounded projections in plane of blade; blade scarcely to moderately broadened. Bulb spherical.

Larva.—Usually large, 4 to 5 mm. in length. Usually shining white.

Head: Mandibles short and compact; only terminal tooth developed on each, a minute second tooth sometimes present; teeth alternating; in some tropical species the single tooth is greatly broadened and flattened, with numerous fine notches on cutting surface. Paraclypeal phragma with both dorsal and ventral process well developed; ventral as long as or only slightly shorter than dorsal, strong. Sensory organs usually heavily sclerotized and dark.

Body: Anterior spiracles small, never lobed, only slightly wider than base; bulbs few, in 2 rows. Abdominal cuticular processes usually minute and scattered, sometimes in rather regular rows with the largest processes anteriorly and posteriorly in the bands; anterior processes anteriorly directed; central processes minute. Posterior spiracles either with 3 bulbs, or with a nearly complete circle of bulbs, usually bearing a conical projection centrally. Posterior end rounded; without tubercles.

Malloch erected the genus *Limnoagromyza* for a single species, *L. dianthereae* Malloch. He separated this genus from *Melanagromyza* on the basis of the presence of some microscopic hairs on the frontal lunule. The genus is placed here, since a study of three paratypes, including the male terminalia, revealed that the species belongs to *Melanagromyza*.

Enderlein erected four genera based upon such characters as elongation of the proboscis (*Aulomyza, Solenomyza*), 3 + 0 dc setae (*Solenomyza, Hexomyza*), and extent of the costa, which reaches R_{4+5} (*Triopisopa*) instead of M_{1+2}. These characters are not of generic value, as is demonstrated under the section on phylogeny.

Hendel (1931*c*) described 21 Palearctic species, and since that time six more have been added to that fauna. Hendel found that some of Strobl's species were based upon previous misidentifications by Schiner (1864) and that Melander, having material from Strobl, had introduced these names into the North American fauna.

NEW WORLD SPECIES IN THE GENUS MELANAGROMYZA

Melanagromyza aeneiventris (Fallén)

Agromyza aeneiventris Fallén, 1823, Dipt. Suec., Agromyzid., 2 (37):4: Malloch, 1934, Dipt. Patag. S. Chile, 6:481.

Melanagromyza aeneiventris (Fallén): Hendel, 1920, Arch. Naturgesch., Abt. A., 84:126; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:158.

Agromyza cunctans Schiner, 1864 (*nec* Meigen, 1830), Fauna Austr., Flieg., 2:304; Melander, 1913, Jour. N. Y. Ent. Soc., 21:251.

Agromyza pulicaria Schiner, 1864 (*nec* Meigen, 1830), Fauna Austr., Flieg., 2:304.

Agromyza pinguis Strobl, 1898 (*nec* Fallén, 1820), Mitt. Naturwiss. Ver. Steier., 34:271.

? *Agromyza cirsii* Rondani, 1875, Boll. Soc. Ent. Ital., 7:180.

The synonymy listed above is taken from Hendel (1931*c*). Melander has a pair of *A. cunctans* of Schiner, one from California and one from Washington. The larvae mine in the pith of stems of various composites and *Urtica dioica* L. in Europe. Europe, Siberia, Argentina, and western North America.

Melanagromyza aldrichi Frick, new name

Agromyza tibialis Frost, 1936 (*nec* Fallén, 1823), Ann. Ent. Soc. Amer., 29:312. Primary homonym.

Dr. J. M. Aldrich was the first to collect this species in 1926, and it is named in his honor. Canal Zone, Guatemala.

Melanagromyza angelicae (Frost), new combination

Agromyza angelicae Frost, 1934, Ent. News, 45:40.

Reared from stems of *Angelica atropurpurea*. New York, California.

Melanagromyza angolae (Malloch), new combination

Agromyza angolae Malloch, 1934, Dipt. Patag. S. Chile, 6:483; Ortiz, 1946, Cat. Dipt. Chile, p. 141.

Chile.

Melanagromyza approximate (Frost), new combination

Agromyza approximata Frost, 1936, Ann. Ent. Soc. Amer., 29:316.

Closely related to *Melanagromyza caerulea* (Malloch). Canal Zone, Guatemala.

Melanagromyza buskei (Frost), new combination

Agromyza buskei Frost, 1936, Ann. Ent. Soc. Amer., 29:315.

Canal Zone.

Melanagromyza caerulea (Malloch), new combination

Agromyza caerulea Malloch, 1913, Ann. Ent. Soc. Amer., 6:322; Bailey and Plank, 1940, Jour. Econ. Ent., 33:704.

The larvae mine sweet-potato seed. Mexico, Puerto Rico.

Melanagromyza crotonis (Frost), new combination

Agromyza crotonis Frost, 1936, Ann. Ent. Soc. Amer., 29:313.

The larvae mine the leaves of *Croton billbargianus* Muell. and *Clitoria* sp. Canal Zone, Costa Rica.

Melanagromyza diadema (Melander), new combination

Agromyza diadema Melander, 1913, Jour. N. Y. Ent. Soc., 21:259.

Agromyza melanderi Hendel, 1923 (n.n. for *A. diadema* Melander, 1913, *nec A. diademata* Bigot, 1891), Konowia, 2:145.

Hendel's homonymy is not accepted. Haiti.

Melanagromyza dianthereae (Malloch), new combination

Limnoagromyza dianthereae Malloch, 1920, Bull. Brooklyn Ent. Soc., 15:147.

Three paratypes were studied, and of these only one female, from Muncie, Illinois, has setae on the lunule. There are six setae, three on each side above the antennae, which are approximately the length of the seta on the second antennal segment. The other two specimens, a male and a female from Lafayette, Indiana, lack these setae. The dissected male terminalia reveal that the species belongs to *Melanagromyza*. The terminalia are distinctive in having the pregonites separated from the ninth sternite by an inconspicuous suture. The larvae mine the stems of *Dianthera americana*. Illinois, Indiana.

Melanagromyza gibsoni (Malloch), new combination

Agromyza gibsoni Malloch, 1915, Proc. U. S. Nat. Mus., 49:106.

Arizona.

Melanagromyza lacustris (Malloch), new combination

Agromyza lacustris Malloch, 1934, Dipt. Patag. S. Chile, 6:482.

Argentina.

Melanagromyza lappae (Loew)

Agromyza lappae (Loew), 1850, Stettin. ent. Ztg., 11:380.

Melanagromyza lappae (Loew): Hendel, 1920, Arch. Naturgesch., Abt. A., 84:126; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:167.

Agromyza aeneiventris Schiner, 1864 (*nec* Fallén, 1823), Fauna Austr., Flieg., 2:504; Melander, 1913, Jour. N. Y. Ent. Soc., 21:251.

Agromyza burgessi Malloch, 1913, Ann. Ent. Soc. Amer., 6:323.

Agromyza plumiseta Malloch, 1913, Ann. Ent. Soc. Amer., 6:324. New synonymy.

Hendel (1931*c*) synonymized all the above-listed species with the exception of *A. plumiseta*, which Melander, in manuscript notes, places as a synonym of *A. aeneiventris*. Melander has specimens of *M. aeneiventris* (Schiner) obtained from Strobl. The larvae mine in the pith of stems of various composites. Europe, Siberia, Puerto Rico, Washington, and Idaho.

Melanagromyza longicauda (Curran), new combination

Agromyza longicauda Curran, 1928, Insect. Porto Rico and Virgin Islands, 11:65.

St. Croix and St. Thomas Islands, West Indies.

Melanagromyza longiseta (Malloch), new combination

Agromyza longiseta Malloch, 1913, Ann. Ent. Soc. Amer., 6:326; Frost, 1936, Ann. Ent. Soc. Amer., 29:318.

Mexico, Guatemala, Canal Zone.

Melanagromyza mallochi (Hendel), new combination

Agromyza eupatoriae Malloch, 1915 (*nec* Kaltenbach, 1874), Proc. U. S. Nat. Mus., 49:107; Frost, 1924, Cornell Mem., 78:42. Primary homonym.

Agromyza mallochi Hendel, 1923 (n.n. for *A. eupatoriae* Malloch, 1915, *nec* Kaltenbach, 1874), Konowia, 2:145.

Reared from *Eupatorium odoratum.* Puerto Rico.

Melanagromyza marellii (Brèthes), new combination

Agromyza marellii Brèthes, 1920, An. Soc. Rur. Argent., 54:284.

Argentina.

Melanagromyza orbitalis (Frost), new combination

Agromyza orbitalis Frost, 1936, Ann. Ent. Soc. Amer., 29:314.

Closely related to *M. longiseta* (Malloch). Canal Zone.

Melanagromyza pulicaria (Meigen)

Agromyza pulicaria Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:170.

Melanagromyza pulicaria (Meigen): Hendel, 1920, Arch. Naturgesch., Abt. A., 84:127.

Agromyza morionella Schiner p.p., 1864 (*nec* Zetterstedt, 1848), Fauna Austr., Flieg., 2:305; Melander, 1913, Jour. N. Y. Ent. Soc., 21:252.

Melanagromyza olgae Hering, 1922, Deutsch. ent. Zeitschr., 1922:424; Hendel, 1923, Konowia, 2:142.

Melander has a single specimen of *A. morionella* Schiner from Washington, as well as six obtained from Strobl. Europe, Siberia, Persia, China, and western North America.

Melanagromyza riparella (Hendel), new combination

Agromyza riparia Malloch, 1915 (*nec* van der Wulp, 1871), Proc. U. S. Nat. Mus., 49:105. Primary homonym.

Agromyza riparella Hendel, 1923 (n.n. for *A. riparia* Malloch, 1915, *nec* van der Wulp, 1871), Konowia, 2:145.

Illinois.

Melanagromyza salicis (Malloch), new combination

Agromyza salicis Malloch, 1913, Ann. Ent. Soc. Amer., 6:314.

From willow. Massachusetts, New York.

Melanagromyza schineri (Giraud)

Agromyza schineri Giraud, 1861, Verh. zool.-bot. Ges. Wien, 11:484; Malloch, 1913, Ann. Ent. Soc. Amer., 6:327.

Melanagromyza schineri (Giraud): Hendel, 1920, Arch. Naturgesch., Abt. A., 84:128.

Three specimens in the State College of Washington collection were reared from galls on *Populus* twigs at Pullman, Washington. The larvae of this species form galls on *Populus* and *Salix* species. Europe, Canada, Massachusetts, Washington.

Melanagromyza similata (Malloch), new combination

Agromyza similata Malloch, 1918, Canad. Ent., 50:178.

Illinois.

Melanagromyza simplex (Loew)

Agromyza simplex Loew, 1869, Berl. ent. Zeitschr., 13:46; Malloch, 1913, Ann. Ent. Soc. Amer., 6:315.

Melanagromyza simplex (Loew): Hendel, 1920, Arch. Naturgesch., Abt. A., 84:128.

Triopisopa simplex (Loew): Enderlein, 1936, Tierw. Mitteleur., 6 (3):179.

Agromyza maura Sajo, 1896 (*nec* Meigen, 1838), Ill. Wochenschr. Ent., 1:597.

The larvae mine beneath the epidermis of the stems of *Asparagus officinalis.* Widespread in Europe and North America.

Melanagromyza subvirens (Malloch), new combination

Agromyza subvirens Malloch, 1915, Proc. U. S. Nat. Mus., 49:105.

Illinois.

Melanagromyza tamia (Melander), new combination

Domomyza tamia Melander, 1913, Jour. N. Y. Ent. Soc., 21:258.

In this species the costa reaches R_{4+5} instead of M_{1+2}. Washington.

Melanagromyza tetrae (Malloch), new combination

Agromyza tetrae Malloch, 1934, Dipt. Patag. S. Chile, 6:483; Ortiz, 1946, Cat. Dipt. Chile, p. 141.

Chile.

Melanagromyza tiliae (Couden), new combination

Agromyza tiliae Couden, 1908, Proc. Ent. Soc. Wash., 9:34; Malloch, 1913, Ann. Ent. Soc. Amer., 6:327.

Reared from galls on twigs of *Tilia americana.* Missouri, Virginia, Pennsylvania.

Melanagromyza virens (Loew), new combination

Agromyza virens Loew, 1869, Berl. ent. Zeitschr., 13:46.

Widespread in North America.

Melanagromyza viridis (Frost), new combination

Agromyza viridis Frost, 1931, Canad. Ent., 63:277.

There is a paratype in the California Academy of Sciences collection. Reared from zinnia. California.

Melanagromyza websteri (Malloch)

Agromyza schineri Aldrich, 1912 (*nec* Giraud, 1861), *in* Amundsen, 1912, Calif. Mon. Bull., 1:730.

Agromyza websteri Malloch, 1913, Ann. Ent. Soc. Amer., 6:325.

Melanagromyza websteri (Malloch): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:180.

This species was reared from galls on twigs of pink wistaria from Japan. To date the species has not been definitely reported from the United States.

Melanagromyza winnemanae (Malloch), new combination

Agromyza winnemanae Malloch, 1913, Ann. Ent. Soc. Amer., 6:314.

Maryland.

3. Genus *Ophiomyia* Braschnikov

[Gr., *ophios,* snake; plus *myia,* fly—in reference to the serpentine mines made by the larvae of *O. maura*]

Ophiomyia Braschnikov, 1897, Ann. Inst. Agron. Moscow, 3:40; Hendel, 1920, Arch. Naturgesch., Abt. A., 84:128; de Meijere, 1925, Tijdschr. Ent., 68:248; Hering, 1927, Tierw. Deutschl., 6:35; Malloch, 1927, Proc. Linn. Soc. N.S.W., 52:424; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:180; Malloch, 1935, Bull. Bishop Mus., 114:18; Hendel, 1936, *in* Lindner: Die Flieg. palaearkt. Reg., 59:569; de Meijere, 1937, Tijdschr. Ent., 80:177; Hering, 1943, Eos, 19:52.

Siphonomyza Enderlein, 1936, Tierw. Mitteleur., 6 (3):179.

Stirops Enderlein, 1936, Tierw. Mitteleur., 6 (3):179; Enderlein, 1936, Mitt. dtsch. ent. Ges., 7:42.

Stiropomyza Enderlein, 1936, Tierw. Mitteleur., 6 (3):179.

Type.—*Agromyza maura* Meigen, 1838 (as *A. pulicaria* Meigen, 1838), monobasic.

Types of synonyms.—*Siphonomyza: Agromyza proboscidea* Strobl, 1900, monobasic; *Stirops: Ophiomyia submaura* Hering, 1926, by subsequent designation of Enderlein, 1936*b*; *Stiropomyza: Phytomyza aeneonitens* Strobl, 1893, monobasic.

Adult.—Moderately large to large, robust, 1.5 to 4 mm. in body length. Shining black, or opaque; halteres black. Adults usually with sexual dimorphism; the males having the vibrissae composed of a distinct pencil or fascicule of setae.

Head: As viewed laterally, anterior angles of subcranial margin usually produced anteriorly into an angle, sometimes acute, particularly in males; mesofacial plate with elongated fusiform median carina, widest immediately ventrad of antennal bases; lunule broad, very low, frontal vitta as long as broad, or slightly longer. Vertical triangle moderately large, scarcely more than half the distance to ptilinal fissure; ocellar triangle normal. Antennae somewhat diverging from one another; third segment rounded, broader than long. Proboscis short, or mediproboscis and labella elongate. Setae: vi in female normal, simple, in male a large conspicuous fascicula (except in *O. aeneonitens* Strobl); usually 2, sometimes 3 ifo; 2 sfo; os erect or dorsally directed.

Setal pattern of thorax: 1 h; 1 prs; 1 sa; 1 ia; 2 pa; 2 + 0 dc; 0 prsc; about 6 to 8 rows of acr, seldom posterior to first pair of dc; 1 pp; 2 npl; 1 aes; 1 kes.

Wing: Very similar to those of other genera in Agromyzinae. Costa usually reaching M_{1+2} (reaching R_{4+5} or slightly beyond in 6 species in Europe); m-m present (absent in *O. aeneonitens*).

Male terminalia: Aedeagal apodeme extending posteriorly within ninth tergite; epiphallus short; aedeagal hood moderately broadened; short, not produced posteriorly, shortened anteriorly because ninth sternite and pregonites are approximate dorsad of aedeagal apodeme. Phallophore moderately short, not extending anteriorly on aedeagal apodeme; portion bearing phallus short, tubular. Phallus moderately short, mostly membranous; basal section relatively short, broadly sclerotized, in some nearly forming a tube, bearing very weak ventral processes; median section in type mostly membranous but usually moderately sclerotized, complex, shortened; distal section membranous, complex. Ninth sternite with sidepieces moderately broadened, margins regular; posterior arms strongly curved dorsally and inward, elongated; hypandrial apodeme variously developed, subtriangular to linear, somewhat ventrally directed. Pregonites completely separated from ninth sternite; not produced ventrally but slightly produced inwardly, bearing a few sensory pores; greatly elongate posteriorly, being produced dorsally nearly to mid-line, following curvature of posterior arms of ninth sternite. Postgonites moderately broadened, long, flattened; attached posteriorly to short phallophore and anteriorly to pregonites, where the short inner dorsal process arises. Ninth tergite ventrally articulated to ninth sternite; strongly receding dorsad of articulation; ventrad of articulation either projecting forward or at least not receding. Surstyli narrow; on extreme anterior margin of ninth tergite; extending somewhat ventrally, strongly inward; bearing numerous heavy, blunt spines and a few setae, all directed inward; moderately broad, rather heavily sclerotized inner pieces extending dorsally, attaching to long posterior projections of ninth sternite. Bacilliform sclerites inconspicuous, narrowly united posteriorly. Cerci moderately short, not expanded centrally; somewhat curving toward each other ventrally. Ejaculatory apodeme relatively large; base partly sclerotized around spherical bulb, broadened opposite plane of blade; stem relatively short, with or without a single short rounded projection in plane of blade; blade narrowly expanded to subcircular.

Larva.—(Compiled from de Meijere, 1925, 1937, 1938.) Moderately large. Whitish.

Head: Mandibles of vastly different size, both teeth of right mandible anterior to those of left mandible; base of long right mandible sometimes appearing as a projection, making 4 or 5 projections in a row. Paraclypeal phragma with ventral arm of dorsal process originating posteriorly; very elongate, equal to or exceeding length of dorsal arm; ventral process subequal to ventral arm of dorsal process. Sensory organs darkly pigmented.

Body: Anterior spiracles not divided, sometimes distally expanded; each bearing 2 rows of bulbs. Abdominal cuticular processes strong; bands centrally with a wide band of very minute processes; those anterior to this band anteriorly directed and those posterior, posteriorly directed; a few rows of each. Posterior spiracles simple or 2-lobed depending upon the number of bulbs, which vary from 3 to 14. Posterior end rounded or somewhat produced ventrally; anal lobes sometimes moderately enlarged, rounded.

The genus *Ophiomyia* was originally erected to include species with cross vein r-m distantly removed from the wing base, beyond the distal termination of R_1 in the costa; cross vein m-m well removed from r-m; puparium flattened, remaining in the mine. Most species since added to the genus have the cross veins nearer the wing base, and this character is no longer of generic value. As far as is known, all included species pupate in the mines.

Enderlein's genera, based on the elongation of the proboscis (*Siphonomyza*), reduction of the costa from the apex of M_{1+2} to R_{4+5} (*Stiropomyza, Stirops*), and the absence of crossvein m-m (*Stiropomyza*), are untenable as previously demonstrated.

This is a small genus, there being only thirteen species known from the Palearctic region in 1931 (Hendel). Since that time about six more have been described. Hendel found many misidentifications in the various European collections, and his arrangement of species forms a basis for evaluating the North American fauna.

New World Species in the Genus Ophiomyia

Ophiomyia congregata (Malloch), new combination

Agromyza congregata Malloch, 1913, Ann. Ent. Soc. Amer., 6:328.

Arizona.

Ophiomyia coniceps (Malloch), new combination

Agromyza coniceps Malloch, 1915, Proc. U. S. Nat. Mus., 49:107.

Reared from *Sonchus asper* L. Utah.

Ophiomyia curvibrissata (Frost), new combination

Agromyza curvibrissata Frost, 1936, Ann. Ent. Soc. Amer., 29:309.

Guatemala.

Ophiomyia fasciculata (Malloch), new combination

Agromyza fasiculata Malloch, 1934, Dipt. Patag. S. Chile, 6:479.

Argentina.

Ophiomyia hirticeps (Malloch), new combination

Agromyza hirticeps Malloch, 1934, Dipt. Patag. S. Chile, 6:481.

Argentina.

Ophiomyia insularis (Malloch), new combination

Agromyza insularis Malloch, 1913, Ann. Ent. Soc. Amer., 6:318; Wolcott, 1936, Jour. Agric. Univ. Puerto Rico, 20:389.

The larvae mine the leaves of Chinese mustard. Cuba, Puerto Rico.

Ophiomyia lantanae (Froggatt)

Agromyza lantanae Froggatt, 1919, Agric. Gaz. N.S.W., 30:665; Aldrich, 1923, Proc. Hawaii. Ent. Soc., 5:262; Perkins and Sweezey, 1924, Bull. Exp. Sta. Hawaii. Sugar Plant. Assoc., Ent., 16:1.

Ophiomyia lantanae (Froggatt): de Meijere, 1925, Tijdschr. Ent., 68:253.

The larvae mine the seeds of *Lantana* sp. Introduced into various tropical and subtropical areas where lantana has become a pest. Native to Mexico and Guatemala.

Ophiomyia major (Strobl)

Agromyza major Strobl, 1900, Wissensch. Mitt. Bosn. u. Herzegow., 7:266.

Ophiomyia major (Strobl): Hendel, 1920, Arch. Naturgesch., Abt. A., 84:130; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:187.

Agromyza vibrissata Malloch, 1913, Ann. Ent. Soc. Amer., 6:316.

Hendel (1920) synonymized *A. vibrissata* with this southern European species. Europe, Syria; Georgia in North America.

Ophiomyia maura (Meigen)

Agromyza maura Meigen, 1838, Syst. Beschr. bekann. eur. zweifl, Insekt., 7:399.

Ophiomyia maura (Meigen): Hendel, 1920, Arch. Naturgesch., Abt. A., 84:129; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:188.

Agromyza curvipalpis Zetterstedt, 1848, Dipt. Scand., 7:2782; Melander, 1913, Jour. N. Y. Ent. Soc., 21:251.

Agromyza bicornis Kaltenbach, 1869, Verh. naturh. Ver. preuss. Rheinl. und Westphal., 26:195.

Agromyza affinis Malloch, 1913, Ann. Ent. Soc. Amer., 6:317.

Agromyza minima Malloch, 1913, Ann. Ent. Soc. Amer., 6:328. New synonymy.

Agromyza texana Frost, 1924 (*nec* Malloch, 1913), Cornell Mem., 78:42.

Hendel (1931*c*) synonymized all the species except *A. minima*, which Melander has synonymized in manuscript notes. Melander has 23 specimens of *A. curvipalpis* from Washington, Idaho, and Massachusetts. The larvae mine the leaves of *Solidago* sp., *Aster* sp., and *Eupatorium* sp. Widespread in Europe and North America.

Ophiomyia oralis (Frost), new combination

Agromyza oralis Frost, 1936, Ann. Ent. Soc. Amer., 29:309.

Closely related to *O. punctohalterata* (Frost). Guatemala.

Ophiomyia proboscidea (Strobl)

Agromyza proboscidea Strobl, 1900, Wissensch. Mitt. Bosn. u. Herzegow., 7:265.

Ophiomyia proboscidea (Strobl): Hendel, 1920, Arch. Naturgesch., Abt. A., 84:129; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:195.

Siphonomyza proboscidea (Strobl): Enderlein, 1936, Tierw. Mitteleur., 6 (3):179.

Agromyza prominens Becker, 1908, Mitt. zool. Mus. Berl., 4:170.

Agromyza texana Malloch, 1913, Ann. Ent. Soc. Amer., 6:319.

Hendel (1931*d*) placed *A. texana* in synonymy. The larvae mine the leaves and stems of *Aster* sp., *Hieracium* sp., and *Satureia* sp. in Europe. Widespread in Europe and recorded from Texas, Maryland, and Virginia in North America.

Ophiomyia punctohalterata (Frost), new combination

Agromyza punctohalterata Frost, 1936, Ann. Ent. Soc. Amer., 29:311.

Peculiar in having a yellow spot on the knob of the halteres. Guatemala.

Ophiomyia setifrons (Melander), new combination

Agromyza setifrons Melander, 1913, Jour. N. Y. Ent. Soc., 21:260.

Washington, Idaho.

4. Genus *Tylomyza* Hendel

[Gr., *tylos*, knob; plus *myza*]

Tylomyza Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:181 (as subgenus); van den Bruel, 1933, Bull. Inst. agron. Sta. Rech., Gembloux, 2:26; Mesnil, 1934, Bull. Soc. Ent. France, 39:131; Enderlein, 1936, Tierw. Mitteleur., 6 (3):179; Hendel, 1936, *in* Lindner: Die Flieg. palaearkt. Reg., 59:569; Frey, 1941, Enum. Insect. Fenn., 6:19.

Siridomyza Enderlein, 1936, Tierw. Mitteleur., 6 (3):179.

Type.—*Madiza pinguis* Fallén, 1820, by original designation.

Type of synonym.—*Ophiomyia madizina* Hendel, 1920, monobasic.

Adult.—Moderately large, robust, 2 to 3.5 mm. in body length. Black, shining or opaque; halteres black. Adults with sexual dimorphism; the males lack the sfo setae.

Head: Mesofacial plate with median carina hemispherical immediately ventrad of and between antennal bases, low convex ventrally; lunule broad, low, about one-fourth distance to ocellar triangle; frontal vitta as broad as long; genovertical plates shining. Vertical triangle very large, conspicuous, shining, somewhat more than half the width between eyes at vertex, extending nearly to lunule; ocellar triangle normal. Antennae somewhat diverging from one another; third segment rounded, slightly broader than long. Proboscis with mediproboscis and labella elongate. Setae: vi moderately strong, simple in both sexes; 2 ifo; 2 sfo in females, absent in males; os long, anteriorly directed, in males more strongly developed and more numerous.

Setal pattern of thorax: 1 h; 1 prs; 1 sa; 1 ia; 2 pa; 2 + 0 or 3 + 0 dc; 0 prsc; about 6 to 8 rows of acr ending posteriorly between first pair of dc; 1 pp; 2 npl; 1 aes; 1 kes.

Wing (fig. 19): Costa reaching M_{1+2}; m-m present, not farther from r-m than length of m-m.

Male terminalia: Aedeagal apodeme extending posteriorly within ninth tergite; epiphallus short, blunt; aedeagal hood short, not broad, not extending anteriorly. Phallophore short, hardly extending anteriorly over aedeagal apodeme; portion bearing phallus very short. Phallus relatively shortened, moderately sclerotized; basal section composed of one very broad, heavily sclerotized piece, only remnants of the other present, ventral processes faintly discernible; median section rather complex, doubled back dorsally, well removed from basal section; distal section short, sclerotized, closely associated with median section; the whole broadly surrounded by membrane. Ninth sternite subtriangular; sidepieces moderately broadened, constricted at articulation with ninth tergite; posterior arms strongly elongate dorsally and inwardly, approximate centrally;

hypandrial apodeme a small thickening, ventrally directed. Pregonites broad; each bearing 2 or 3 sensory pores on inward-directed portion; strongly projecting dorsally, following posterior arms of ninth sternite. Postgonites broad, somewhat ventrally curved, flattened plates attached to phallophore posteriorly and extending anteriorly to join pregonites; at this attachment the inner process extends dorsally to the small phallophore posterior to the posterior arms of the ninth sternite. Ninth tergite articulated to ninth sternite dorsad of mid-line; receding dorsad of and strongly or slightly proceeding ventrad of articulation. Surstyli narrow, not separated by a suture; anteroventrally elongated; bearing heavy spines and a few setae along ventral and anterior margins, extending dorsally almost to articulation with ninth sternite; inner process broadly extending dorsally, attaching to bacilliform sclerites near mid-line. Bacilliform sclerites rather inconspicuous; extending posteriorly and ventrally to unite narrowly before cerci. Cerci attached to bacilliform sclerites ventrad of their mid-point; relatively large, somewhat flattened, slightly or not incurved. Ejaculatory apodeme relatively large; base greatly widened at right angles to plane of blade, partly surrounding broadened bulb; stem long, with a slightly lengthened, blunt projection in plane of blade; blade ovoid. Ejaculatory bulb rounded, elongated opposite plane of blade.

Larva.—(Compiled from de Meijere, 1925, and Mesnil, 1934.) Five to 6 mm. in length; moderately slender. Pale yellow.

Head: Mandibles each with a strong terminal tooth and a very small second one. Paraclypeal phragma with ventral arm of dorsal process very strong, elongate, more than equaling dorsal arm; ventral process subequal to dorsal process.

Body: Anterior spiracles simple, not lobed; each bearing 2 rows of about 10 bulbs. Bands of abdominal cuticular processes with a few rows of very strong anteriorly directed anterior and posteriorly directed posterior processes; centrally a broad band of very minute processes. Posterior spiracles each with about 9 bulbs branching off irregularly, spiracles only slightly expanded distally. Posterior end without tubercles; truncate, slightly produced ventrally.

Hendel (1931*c*) originally proposed *Tylomyza* as a subgenus of *Ophiomyia*. Enderlein (1936*a*) raised it to full generic standing and proposed the name *Siridomyza* for species having 3 pair of dc setae. Although *Tylomyza* has remained a valid genus, *Siridomyza* has been considered a synonym since that time.

Two species are known from Europe. A number of North American species have been synonymized with these by various workers.

New World Species in the Genus Tylomyza

Tylomyza pinguis (Fallén)

Agromyza pinguis (Fallén): Fallén, 1820, Dipt. Suec., Oscinid., 2 (20):10 (as *Madiza*).

Ophiomyia pinguis (Fallén): Hendel, 1920, Arch. Naturgesch., Abt. A., 84:130.

Tylomyza pinguis (Fallén): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:193 (as subgenus); Frey, 1941, Enum. Insect. Fenn., 6:19.

Agromyza pulicarioides Strobl, 1900, Wien. ent. Zeitung, 19:63.

Agromyza pseudocunctans Strobl, 1900, Wien. ent. Zeitung, 19:64; Melander, 1913, Jour. N. Y. Ent. Soc., 21:251.

Agromyza tuberculata Becker, 1903, Mitt. zool. Mus. Berl., 2:189.

Agromyza nasuta Melander, 1913, Jour. N. Y. Ent. Soc., 21:260.

Agromyza youngi Malloch, 1914, Ent. News, 25:312; Malloch, 1924, Canad. Ent., 56:192. New synonymy.

Melander has specimens of *A. pseudocunctans* from Washington and Idaho, which included females of *A. nasuta*, all of the specimens of *A. nasuta* being males. Terminalia studies of a male of *A. youngi* identified by Frost in the collection of C. W. Sabrosky confirmed that *A. youngi* is a synonym of *T. pinguis*. Malloch (1924*a*) considered *A. youngi* to be a synonym of *A. nasuta* and that *A. nasuta* was actually *T. madizina* Hendel on the basis of a third dc seta. *T. pinguis* may have a very weak third dc (Hendel, 1931*c*) as did the specimen of *A. youngi* examined and a pair of *T. pinguis* obtained from Dr. Hering. The larvae of this species mine the leaves and shoots of *Cichorium intybus* L. and possibly *Lampsana communis* L. in Europe. Widespread in Europe, Asia Minor, and Central Asia, and probably also widespread in North America.

Tylomyza madizina (Hendel)

Ophiomyia madizina Hendel, 1920, Arch. Naturgesch., Abt. A., 84:130.

Tylomyza madizina (Hendel): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:185 (as subgenus); Frey, 1941, Enum. Insect. Fenn., 6:19.

Siridomyza madizina (Hendel): Enderlein, 1936, Tierw. Mitteleur., 6 (3):179.

Agromyza morionella Schiner p.p., 1864 (*nec* Zetterstedt, 1848), Fauna Austr., Flieg., 2:305; Melander, 1913, Jour. N. Y. Ent. Soc., 21:252.

Melander has six specimens of *A. morionella* of Schiner from Strobl and one from Washington. A series in the California Academy of Sciences collection have the third dc more than half the length of the second dc. The wing venation agrees with that described and figured by Hendel (1931*c*), and the male terminalia are distinct from those of *T. pinguis.* The specimens were collected by M. C. van Duzee in New York. The biology of this species is not known. Widespread in Europe, North Africa, and North America.

Subfamily PHYTOMYZINAE Fallén

Phytomyzides Fallén, 1823, Dipt. Suec., Phytomyzid., 2 (41):1; Zetterstedt, 1840, Insecta Lapponica, Dipt., 3 (5):791; Zetterstedt, 1848, Dipt. Scand., 7:2800; Zetterstedt, 1860, Dipt. Scand., 14:6464.

Phytomyzidae Loew, 1862, Smithson. Misc. Coll., 1:47; Osten Sacken, 1878, Smithson. Misc. Coll., 16:210; Williston, 1888, Synop. and Gen. N. A. Dipt., p. 64; Collin, 1911, Ent. Mon. Mag., 22:255.

Phytomyzini Lioy, 1864, Atti Ist. Veneto, (3) 9:1315.

Phytomyzinae Williston, 1896, Manual N. A. Dipt., 2d ed., p. 103; Aldrich, 1905, Smithson. Misc. Coll., 46:645; Malloch, 1913, Proc. U. S. Nat. Mus., 46:129; Frey, 1921, Acta Soc. Faun. Flor. Fenn., 48:217.

Astejina Rondani, 1856, Dipt. Ital. Prod., 1:135.

Type.—Phytomyza Fallén, 1810.

Adult.—Wing with subcosta becoming a fold distally, terminating in the costa basad of R_1, costa not indented at that point, R_1 not expanded at costal union (fig. 16, *b*); mouthparts with galea rudimentary and with premental basal projections present; male terminalia with postgonites vertical, strongly elongate vertically, terminating ventrally with teeth, or smoothly and narrowly rounded; wings, when at rest, usually folded one above the other over the abdomen.

Larva.—Paraclypeal phragma of cephalopharyngeal apparatus relatively narrow; dorsal arm nearly straight; ventral arm usually very weakly developed and sclerotized for only a short distance from base, rarely elongate, if so then very slender (fig. 14).

Fallén (1823*b*) included within Phytomyzides the genera *Dipsa* Fallén (synonym of *Musidora* Meigen, 1800) (Musidoridae), *Phytomyza,* and *Trineura* (synonym of *Phora* Latrielle) (Phoridae). This group was distinguished by the position of the cross vein—at the base of the wing, basad of the apex of R_1—and the absence of any cross vein near the middle of the wing. There is nothing in the descriptions to indicate that Fallén detected the presence of an extra cross vein (m-m) immediately basad of r-m in the species *Napomyza lateralis* (Fallén). Zetterstedt (1840, 1848, 1860) considered only *Phytomyza* and *Lonchoptera* Meigen (synonym of *Musidora* Meigen) as belonging to Phytomyzides.

Rondani (1856) separated the stirps Astejina quite distantly from Agromyzina and noted that it included parts of Phytomyzides, Heteromyzides, and Agromyzides of Bigot. Two genera were included: *Phytomyza* (arista nude or pubescent) and *Asteia* Meigen (Astiidae) (arista bearing long, sparse setulae).

Lioy (1864) based Phytomyzini primarily on the absence of cross vein m-m or its position basad of r-m. Three genera were included: *Dinevra,* n. gen. (synonymous with *Napomyza*), *Phytomyza,* and *Asteia.*

Williston (1896*b*) separated Phytomyzinae by the absence of cross vein m-m and the presence of the vibrissal seta (absent in Ochthiphilinae). Malloch (1913*b*) distinguished Phytomyzinae by the divergent pvt setae, and either the absence of cross vein m-m or, if it is present, its situation basal to or ventral to cross vein r-m. Two genera were mentioned, *Phytomyza* and *Napomyza*.

Frey (1921) separated the subfamily on the basis of certain features of the mouthparts of species in the genus *Phytomyza* which included the rudimentary galea and the presence of the premental basal projections. These characters I found to be constant in the genera *Cerodontha, Liriomyza, Haplomyza,* and *Phytomyza.*

The two general types of subcostal termination were first used by Hendel (1920) in separating out two groups of genera. The subcosta ending basad of R_1 in the costa distinguished the genera included here from those included in the Agromyzinae. De Meijere (1925) noted differences in the cephalopharyngeal apparatus of the larvae. Hendel (1931*a*) correlated the larval and the adult wing characters to separate the two generic groups. His concepts are here considered as of subfamily significance.

5. Genus *Selachops* Wahlberg

[Gr., *selachos*, shark; plus *ops*, face]

Selachops Wahlberg, 1844, Oefvers. VetenskAkad. Förh., 1:67; Wahlberg, 1845, Arsberät. om Framst., åren 1843–1844:173; Zetterstedt, 1848, Dipt. Scand., 7:2792; Zetterstedt, 1860, Dipt. Scand., 14:6463; Rondani, 1875, Boll. Soc. Ent. Ital., 7:167; Bezzi, 1891, Boll. Soc. Ent. Ital., 23:41; Melander, 1913, Jour. N. Y. Ent. Soc., 21:286; Hendel, 1920, Arch. Naturgesch., Abt. A., 84:115; Hering, 1927, Tierw. Deutschl., 6:78; Kloet and Hincks, Check List Brit. Insects, p. 403.

Encoelocera Loew, 1844, Stettin. ent. Ztg., 5:321; Rondani, 1875, Boll. Soc. Ent. Ital., 7:171; Hendel, 1936, *in* Lindner: Die Flieg. palaearkt. Reg., 59:514.

Type.—Selachops flavocincta Wahlberg, 1844, monobasic.

Type of synonym.—Encoelocera: Encoelocera bicolor Loew, 1844, monobasic.

Adult.—Large, 4 mm. in body length. All setae on head and body relatively short and slender. Shining black; posterior two-thirds of scutellum yellow; halteres whitish; wings tinged with yellowish brown.

Head: Triangular when viewed in profile, being very strongly produced anteriorly dorsad of antennae. Postclypeus very long, extending anteriorly nearly to antennal bases; mesofacial plate shortened, antennal bases deeply sunken, separated; frontal lunule large, flat, with a central groove, finely punctate; frontal vitta triangular, acuminate; genovertical plates approximate immediately dorsad of lunule. Frontal triangle about twice as large as ocellar triangle, flattened. First and second antennal segments shortened; third segment very small, rounded, broader than long; arista subapical, moderately long, thickened on basal fifth, distally tapering uniformly. Proboscis very short; labella scarcely broader than mediproboscis; maxillary palpi very broad, relatively short. Setae: vi not differentiated from long setae of subcranial margin; 4 to 7 ifo, directed inward; 2 sfo, directed somewhat dorsally but not outward; both ifo and sfo scarcely differentiated from very numerous, long, inward-directed os.

Setal pattern of thorax: 1 h; 0 prs; 1 sa; 0 ia; 2 pa; 1 dc; 1 prsc; acr very numerous, long, tending to obscure relatively short and slender setae; 4 sc; 1 pp; 2 npl; 1 aes; 1 kes.

Wing (fig. 20): R_1 very long, ending in C three-eighths of distance to apex of wing; C terminating between apices of R_{4+5} and M_{1+2}, but nearer that of R_{4+5}; m-m present.

Male terminalia: Aedeagal apodeme extending posteriorly to anterior margin of ninth tergite; epiphallus relatively long, broad, terminating abruptly in a point; aedeagal hood moderately broad, extending anteriorly beyond anterior margin of ninth tergite. Phallophore extending anteriorly beyond anterior margin of ninth tergite; portion bearing phallus membranous, short.

Phallus relatively short, rather lightly sclerotized; basal section with broad sclerites united dorsally, open below, ventral processes moderately long, extending posteriorly; median section very short, scarcely more than a pair of sclerotized ventral processes which originate on the dorsal surface; distal section relatively long, moderately sclerotized, basal portion nearly tubular, distally composed of a pair of diverging tubules expanded distally. Ninth sternite triangular; sidepieces extremely broadened, with just enough space for phallus between inner margins, posteriorly bearing short ventral processes; very little vertical curvature, thickened, more so posteriorly; hypandrial apodeme absent; posterior arms short, curving dorsally to unite with bacilliform sclerites. Pregonites broadly united to ninth sternite, strongly and broadly curved dorsally; no sensory pores; each bearing a pair of posteriorly directed setulae. Postgonites with outer process extending broadly to phallophore; inner process reaching only about half the distance; ventral portion not elongate ventrally, strongly incurved to terminate in a broadened, flat, rounded area, nearly on mid-line. Ninth tergite covered with relatively long setulae; articulated to ninth sternite about midway between dorsal and ventral margins; receding strongly ventrad of articulation; moderately elongate ventrally; somewhat incurved along posteroventral margins, bearing an irregular row of heavy blunt spines plus numerous smaller ones. Surstyli on anteroventral angles; rounded; completely separated by a suture, each ventrally bearing a very heavy, inward-directed blunt spine; extension from inner margin to bacilliform sclerites moderately broad. Bacilliform sclerites relatively broad, broadly united anterior to cerci. Cerci small; not flattened, relatively slender. Ejaculatory apodeme of moderate size; base small; stem short, relatively slender, curved; blade broadly expanded, distal angles smoothly rounded. Bulb lightly sclerotized on side perpendicular to plane of blade; ejaculatory duct originating laterally.

Larva.—Unknown.

Wahlberg's paper, dated April 10, 1844, antedates that of Loew dated September, 1844, and subsequent workers have accepted Wahlberg's paper as having priority. Hendel (1920, 1936) overlooked this 1844 work and, because Wahlberg's second description actually appeared in 1845 rather than in 1843, gave credit to Loew for the earlier description in his later (1936) paper.

Wahlberg placed *Selachops* in the family Agromyzides s.l. Bezzi (1891) placed *Selachops* in the family Chloropidae, but Hendel (1920, 1936) placed it in the family Agromyzidae, as Zetterstedt (1848) and Rondani (1875) had previously done. Melander (1913) included *Selachops* in his Synopsis. He had no specimens and placed the genus in the Geomyzidae on the basis of earlier descriptions. Terminalia studies have confirmed that this genus belongs to the Agromyzidae.

Dr. Hering mentioned in correspondence that *Selachops flavocincta* is rare in Germany and the adults are found only on "sphagnum-fens." The species is known only from Europe.

6. Genus *Phytobia* Lioy

[Gr., *phyton*, plant; plus *bios*, life.]

Phytobia Lioy, 1864, Atti Ist. Veneto, (3) 9:1313; Coquillett, 1910, Proc. U. S. Nat. Mus., 37:510; Malloch, 1934, Dipt. Patag. S. Chile, 6:466.

Redia Lioy, 1864 (*nec* Filippi, 1837, Trematoda), Atti Ist. Veneto, (3) 9:1313; Coquillett, 1910, Proc. U. S. Nat. Mus., 37:599. New synonymy.

Dizygomyza Hendel, 1920, Arch. Naturgesch., Abt. A., 84:130; de Meijere, 1925, Tijdschr. Ent., 68:253; Hering, 1927, Tierw. Deutschl., 6:38; Malloch, 1927, Proc. Linn. Soc. N.S.W., 52:426; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:17; Hendel, 1936, *in* Lindner: Die Flieg. palaearkt. Reg., 59:569. New synonymy.

Dendromyza Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:22 (as subgenus); Kangas, 1935, Commun. Inst. For. Fenn., 22:1; Kangas, 1949, Ann. Ent. Fenn., Suppl., 14:106. New synonymy.

Liomyzina Enderlein, 1936, Tierw. Mitteleur., 6 (3):180; Enderlein, 1936, Mitt. dtsch. ent. Ges., 7:42. New synonymy.

Type.—*Agromyza errans* Meigen, 1830, monobasic.

Types of homonym and synonyms.—*Redia:* *Agromyza gyrans* Fallén, 1823, by subsequent designation of Coquillett, 1910*b*; *Dizygomyza: Agromyza morosa* Meigen, 1830, by original designation; *Dendromyza: Agromyza carbonaria* Zetterstedt, 1848, by original designation; *Liomyzina: Domomyza lunulata* Hendel, 1920, by subsequent designation of Enderlein, 1936*b*.

Adult.—Variable in size and form, 1.5 to 5 mm. in body length, usually robust. Black or grayish, shining or opaque, variably marked with yellow; scutellum dark, always concolorus with mesonotum; halteres usually whitish or yellowish, rarely extensively brown or black or completely black.

Head: Variable as to form of lunule, frontal vitta, and separation of antennal bases. Mesofacial plate not elongate; frontal vitta often broader than long, depending on size and form of variable lunule. Proboscis short. Antennal bases approximate or separate; third segment usually rounded, rarely pointed distally; in subgenus *Dizygomyza* antennae greatly enlarged in males. Setae: 2 to 5 (usually 3 or 4) ifo; 1 or 2 sfo; os dorsally directed.

Setal pattern of thorax: 1 h; 1 or 2 prs; 1 sa; 1 or 2 ia, rarely absent; 2 pa; 3 + 0 or 3 + 1 dc; 0 or 1 prsc; acr variable, some always present; 1 pp; 2 npl; 1 aes; 1 kes.

Wing (fig. 21): Costa reaching M_{1+2}, rarely R_{4+5}; m-m present, distad of r-m (when C reaches only to R_{4+5} then m-m is beyond center of wing, so that ultimate section of M_{3+4} is subequal to or only slightly longer than the penultimate section).

Male terminalia: Aedeagal apodeme usually posteriorly terminating anterior to ninth tergite; aedeagal hood generally long and broad; phallophore broad, elongate, anteriorly exceeding anterior margin of ninth tergite. Phallus variable; basal section usually with sclerites very broad, ventral processes usually long and generally thickened; median section generally short, tubular, ventral processes usually short, usually thickened; distal section composed of a pair of tubules of variable length, often sigmaform or twisted. Ninth sternite sometimes bearing elongate ventral processes; sidepieces usually elongate, rarely shortened; posterior arms not strongly dorsally curved; hypandrial apodeme absent. Pregonites broadly united to ninth sternite, broadened, sometimes extending inward to mid-line; bearing a few sensory pores and usually 1 to 4 setae posteriorly. Postgonites with outer process very long, usually as long as inner process and extending to phallophore, inner process sometimes shorter; ventral portion usually long but sometimes short, terminating bluntly, or with 1 or 2 blunt teeth; sometimes bearing 1 or more setae posteriorly. Ninth tergite articulated to ninth sternite dorsally; sometimes bearing a small bulbous process dorsad of cerci; ventral margin turned inward and often dorsally; often bearing a few strong spines on posterolateral angles. Surstyli on anterior margin of ninth tergite, usually separated by a distinct suture; directed inward or turned dorsally within ninth tergite, not elongate ventrally; bearing 2 to many spines, spines usually strong, rarely weak, directed dorsally or inward, rarely posteriorly. Cerci short or very long, slender, not greatly flattened. Ejaculatory apodeme with base usually elongate toward phallophore, sometimes sclerotized ventrad of subspherical bulb; stem variable, not possessing short lateral processes, usually broadened; blade variable, outer angles usually rather sharp.

Larva.—Small to large, up to 5 mm. in length in leaf-mining species, to 30 mm. in cambium-mining species; form variable, extremely slender in cambium miners. Whitish.

Head: Mandibles each usually with 2 strong teeth, rarely only 1; alternating to appear as 4 in lateral view. Paraclypeal phragma with dorsal arm of dorsal process slender or somewhat thickened; ventral process usually smaller and shorter. There is rarely a patch of setulae dorsad of antennae.

Body: Anterior spiracles usually not large; knob-shaped or flattened and elongate in one direction, not lobed; bulbs rarely elongate. Abdominal cuticular processes of moderate size, very weakly developed in cambium-mining larvae; bands usually of irregular rows of processes nearly equal in size; sometimes bands divided and bearing no processes centrally. Posterior spiracles either with many bulbs or with only 3; if 3, then one or more often elongate, hooklike, or twisted. Posterior end usually without tubercles, sometimes these present in subgenus *Calycomyza;* anal lobes enlarged in some species in the subgenus *Calycomyza*.

Lioy (1864), in a paper that was ignored by Hendel (1910), was the first to erect a generic concept for this large group. Coquillett (1911) pointed out that Lioy's paper followed the International Rules of Zoölogical Nomenclature and was therefore valid. Malloch (1934*a*) noted that part of Lioy's work was already accepted, but as Malloch did not accept *Dizygomyza,* he placed *Phytobia* as a synonym of *Agromyza.* Lioy separated *Agromyza errans* Meigen on the basis of the position of cross vein m-m, which is at an oblique angle. The genus *Redia* included the species previously in *Agromyza* which have cross vein m-m near the base of the wing. *Liomyzina* was erected for two rather diverse species in the subgenus *Phytobia* that have the costa reaching R_{4+5}. Kangas (1935) raised the subgenus *Dendromyza* to full generic standing. It is here considered a subgenus because of diverse species included in it.

Hendel (1931*a*) proposed nine subgenera which he also called species groups because of a number of diverse species scattered throughout the genus. These groups are here considered subgenera because the general form of the male terminalia is constant throughout the genus. The diverse North American species are placed in the subgenus to which they most nearly conform. I have studied specimens of the designated types of *Phytobia, Poëmyza, Amauromyza, Calycomyza, Trilobomyza, Praspedomyza,* and *Dizygomyza* as well as specimens of European species that belong in *Cephalomyza* and *Icteromyza.*

The genus *Phytobia* appears to be in the process of splitting into a number of genera. The characters found to be of value in delimiting the other genera in the family Agromyzidae are generally lacking within this genus, although the ia seta is absent in *P. hilarella* (Zetterstedt), *P. clara* (Melander), and in one species of *Cephalomyza,* and the prsc setae are absent in a number of subgenera.

Phytobia is a large genus with sixty-two species in the Palearctic region (Hendel, 1931*a*). Since that time about eight new species have been added to that fauna. The genus is well represented in North America. Species that can be placed in subgenera are so listed. A number of species the subgenus of which is not certain are placed at the end of the list of species in the subgenus *Dizygomyza.*

KEY TO SUBGENERA OF *PHYTOBIA*

1. Knob of halteres whitish or yellowish 2
   Knob of halteres partially or entirely brown or black .... (6*e*) *Amauromyza*
2. Lunule low, semicircular in outline; genovertical plates variable 3
   Lunule greatly elongate dorsally, usually laterally constricted above the antennae by the broadening of the very prominent genovertical plates .... (6*c*) *Poëmyza*
3. Antennal bases widely separated; lunule very broad, large, in height about half distance from antennae to ocellar triangle, not sunken 4
   Antennal bases approximate or nearly so; lunule smaller, one-third or less the distance between antennae and ocellar triangle, sunken below frontal vitta 5
4. Frontal vitta yellowish; vertical triangle produced anteriorly to reach lunule (6*d*) *Icteromyza*
   Frontal vitta brown or black; vertical triangle not larger than ocellar triangle (6*i*) *Dizygomyza*
5. Apex of M_{1+2} nearest wing tip; prsc setae absent; one ia seta present, or absent; usually no setae present on mid-tibiae 6
   Apex of R_{4+5} nearest wing tip; prsc setae present; usually two ia setae present; one or two setae present on mid-tibiae .... (6*a*) *Phytobia*

6. Genae not more than one-half eye height; genovertical plates slightly (or not) raised above eyes; two or more sfo setae present; if frontal vitta, antennae, and mesofacial plate yellow, legs also yellow 7

Genae elongate, about two-thirds eye height; genovertical plates markedly raised above eyes; one sfo seta present; frontal vitta, antennae, and mesofacial plate yellow, legs primarily dark (6*b*) *Cephalomyza*

7. Mesonotum with 3 + 1 dc setae; femora yellow, or if black, then with apices yellow 8

Mesonotum with 3 + 0 dc setae; femora entirely black . . . . (6*f*) *Calycomyza*

8. Genovertical plates not sharply raised above frontal vitta . . . . (6*g*) *Trilobomyza*

Genovertical plates very sharply raised above frontal vitta (except in *P. hilarella* and *P. clara*) (6*h*) *Praspedomyza*

6*a*. Subgenus *Phytobia* Lioy

Phytobia Lioy, 1864, Atti Ist. Veneto, (3) 9:1313.

Dendromyza Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:22; Kangas, 1935, Commun. Inst. For. Fenn., 22:1; Kangas, 1949, Ann. Ent. Fenn., Suppl., 14:106. New synonymy.

Liomyzina Enderlein, 1936, Tierw. Mitteleur., 6 (3):180; Enderlein, 1936, Mitt. dtsch. ent. Ges., 7:42. New synonymy.

Type.—Agromyza errans Meigen, 1830, monobasic.

Types of synonyms.—Dendromyza: Agromyza carbonaria Zetterstedt, 1848, by original designation; *Liomyzina: Domomyza lunulata* Hendel, by subsequent designation of Enderlein, 1936*b*.

Usually large, 2.5 to 5 mm. in body length. Black or dark brown; halteres white or yellowish; fringe of calypters dark. Head with antennal bases usually approximate; lunule low, in height one-third or less the length of the frontal vitta. Thorax with prsc setae strongly developed; usually 2 (1 presutural) ia setae present. Legs bearing 1 or 2 setae on mid-tibiae. Wings with ultimate section of M_{3+4} relatively short; apex of R_{4+5} nearest wing tip. Cambium-mining larvae 15 to 30 mm. in length, very slender; leaf-mining larvae short, about 5 mm. in length, robust.

The subgenus *Phytobia* was elevated to full generic rank by Kangas (1935). He removed the biologically diverse species *P. posticata* (Meigen), basing his concept upon the larval morphology and habitat of six other species the biologies of which were known at that time. Since then, Kangas (1949) has described two more species having cambium-mining larvae. Six European species, the biologies of which are unknown, remain in the group; two of them have the costa reaching R_{4+5} and the antennae widely separated.

New World Species in the Genus *Phytobia* (*Phytobia*)

Phytobia (Phytobia) aceris (Greene), new combination

Agromyza aceris Greene, 1917, Jour. Agric. Res., 10:313.

The larvae mine the cambium of *Acer rubrum*. Virginia, West Virginia.

Phytobia (Phytobia) amelanchieris (Greene), new combination

Agromyza amelanchieris Greene, 1917, Jour. Agric. Res., 10:314.

The larvae mine the cambium of *Amelanchier canadensis*. West Virginia.

Phytobia (Phytobia) kallima (Frost), new combination

Agromyza kallima Frost, 1936, Ann. Ent. Soc. Amer., 29:299.

Peculiar in having a dark brown spot on each wing. Canal Zone.

Phytobia (Phytobia) posticata (Meigen), new combination

Agromyza posticata Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:172; Malloch, 1913, Ann. Ent. Soc. Amer., 6:308; Frost, 1924, Cornell Mem., 78:50.

Dizygomyza (*Dendromyza*) *posticata* (Meigen): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:30.

Agromyza virgaureae Kaltenbach, 1869, Verh. naturh. Ver. preuss. Rheinl. und Westphal., 26:195.

Agromyza terminalis Coquillett, 1895, Proc. Acad. Nat. Sci. Phila., 47:318.

Agromyza taeniola Coquillett, 1904, Proc. Ent. Soc. Wash., 6:191.

Agromyza argenteolunulata Strobl, 1909, Wien. ent. Ztg., 28:294.

Malloch (1913*a*) was the first to synonymize *A. terminalis* and *A. taeniola* with *A. posticata.* The larvae mine the leaves of *Aster* sp. and *Solidago* sp. Widespread in Europe and North America.

Phytobia (Phytobia) pruinosa (Coquillett), new combination

Agromyza pruinosa Coquillett, 1902, Jour. N. Y. Ent. Soc., 10:189; Greene, 1914, Jour. Agric. Res., 1:471; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:23.

Greene (1914) reported the first life history of a cambium miner in North America, having found the larvae of this species mining the cambium of *Acer rubrum.* Colorado, Virginia, Illinois.

Phytobia (Phytobia) pruni (Grossenbacher), new combination

Agromyza pruni Grossenbacher, 1915, Bull. Torrey Bot. Club, 42:235; Malloch, 1915, Bull. Ill. Lab., 11:349.

The costa reaches the apex of R_{4+5}. The larvae mine the cambium of *Prunus avium* and *P. domestica.* New York.

Phytobia (Phytobia) waltoni (Malloch), new combination

Agromyza waltoni Malloch, 1913, Ann. Ent. Soc. Amer., 6:303.

Dizygomyza (*Dendromyza*) *waltoni* (Malloch): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:25.

Hendel questionably placed this species as a synonym of *P. carbonaria* (Zetterstedt), 1848. New York.

6*b*. Subgenus *Cephalomyza* Hendel

[Gr., *cephale,* head; plus *myza*]

Cephalomyza Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:32.

Type.—*Dizygomyza luteiceps* Hendel, 1920, by original designation.

Moderately small, 1 to 2.5 mm. in body length. Frontal vitta, antennae, and mesofacial plate yellow. Genae about two-thirds eye height; a broad epistoma present between subcranial margin and mesofacial plate; 1 sfo seta; genovertical plates markedly raised above eye margins. Thorax with ia seta usually present; anepisternum without setulae on dorsal margin.

A small group of but four European species. The life history is known for only one species, *P. cepae* (Hering), 1927, the larvae of which mine in onion leaves.

6*c*. Subgenus *Poëmyza* Hendel

[Gr., *poee,* grass; plus *myza*]

Poëmyza Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:35.

Type.—*Agromyza pygmaea* Meigen, 1830, by original designation.

Of moderate size, 1.5 to 2.5 mm. in body length. Head with antennal bases approximate; lunule greatly elongate dorsally, center part usually constricted laterally above the antennae by broadening of the genovertical plates dorsad of the antennae; genovertical plates prominent, wide, often broadened ventrally, exceeding frontal vitta in height, inner margins distinct. Larvae with posterior spiracles elongate, conical, bearing 3 bulbs; mining in leaves of grasses and sedges.

New World Species in the Genus *Phytobia* (*Poëmyza*)

Phytobia (Poëmyza) atra (Meigen), new combination

Agromyza atra Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:178.

Dizygomyza (*Poëmyza*) *atra* (Meigen): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:35.

Agromyza nigra Macquart, 1835, Hist. Nat. Insect., Dipt., 2:610.

Agromyza imbuta Meigen, 1838, Syst. Beschr. bekann. eur. zweifl. Insekt., 7:400.

Agromyza luctuosa Zetterstedt p.p., 1848 (*nec* Meigen, 1830), Dipt. Scand., 7:2759.

Agromyza angulata Loew, 1869, Berl. ent. Zeitschr., 13:47; Melander, 1913, Jour. N. Y. Ent. Soc., 21:254; Malloch, 1915, Bull. Ill. Lab., 11:359.

Agromyza riparia van der Wulp, 1871, Tijdschr. Ent., 10:205.

Agromyza incisa Rondani, 1875 (*nec* Meigen, 1830), Boll. Soc. Ent. Ital., 7:181.

Agromyza infinita Becker, 1910, Dtsch. ent. Zeitschr., 1910:664.

Phytomyza xanthaspis var. *nigroscutellata* Strobl, 1910, Mitt. Natur. Ver. Steier., 46:218.

The synonymy given above is taken from Hendel (1931*a*). The larvae mine the leaves of *Phragmites communis* Trin. and *Phalaris arundicacea* L. in Europe and *Setaria glauca* in North America. Widespread in Europe and North America.

Phytobia (Poëmyza) cinereifrons (Frost), new combination

Agromyza cinereifrons Frost, 1931, Canad. Ent., 63:276.

Very closely related to *A. angulata* Loew (Frost, 1931). New York.

Phytobia (Poëmyza) coquilletti (Malloch), new combination

Agromyza coquilletti Malloch, 1913, Ann. Ent. Soc. Amer., 6:295.

Dizygomyza (Poëmyza) coquilletti (Malloch): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:42.

Hendel (1931*a*) notes that this species is very close to but not exactly the same as *P. lateralis* (Macquart), 1835. The larvae mine the leaves of oats, barley, and wheat. North America.

Phytobia (Poëmyza) incisa (Meigen), new combination

Agromyza incisa Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:182.

Dizygomyza (Poëmyza) incisa (Meigen): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:38.

Agromyza graminis Kaltenbach p.p., 1858, Verh. naturh. Ver. preuss. Rheinl. und Westphal., 15:142.

Agromyza carbonella Zetterstedt, 1860, Dipt. Scand., 14:6455.

Agromyza atra Brischke p.p., 1881 (*nec* Meigen, 1830), Schrift. Naturf. Ges. Danzig., 5:53.

Agromyza luctuosa Strobl p.p., 1893 (*nec* Meigen, 1830), Wien. ent. Zeitung, 12:134; Melander, 1913, Jour. N. Y. Ent. Soc., 21:254.

Agromyza angulata Malloch, 1913 (*nec* Loew, 1869), Ann. Ent. Soc. Amer., 6:304.

The synonymy given above is taken from Hendel (1931*a*). Melander has specimens of *A. luctuosa* of Strobl from Washington, Idaho, and Massachusetts. The larvae mine the leaves of grasses. I have reared this species from *Agropyron repens* (L.), *Elymus glaucus* Buckl., *Bromus tectorum* L., and *Hordeum vulgare* L. Widespread in Europe and North America.

Phytobia (Poëmyza) inconspicua (Malloch), new combination

Agromyza inconspicua Malloch, 1913, Ann. Ent. Soc. Amer., 6:310.

The larvae mine the leaves of *Agropyron* sp. Colorado.

Phytobia (Poëmyza) muscina (Meigen), new combination

Agromyza muscina Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:177.

Dizygomyza (Poëmyza) muscina (Meigen): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:44.

Agromyza superciliosa Zetterstedt, 1860, Dipt. Scand., 14:6455; Melander, 1913, Jour. N. Y. Ent. Soc., 21:256.

Agromyza vittata Strobl, 1880 (*nec* Meigen, 1838), Obergymnasiums Benedikt., Programm, 14:37.

The synonymy given above is taken from Hendel (1931*a*). Melander has specimens of *A. superciliosa* from Oregon and Washington. I have reared this species from larvae feeding on leaves of *Hordeum murinum* L., *Ehrharta erecta* Lam., and *Agropyron repens* (L.). Europe, western North America.

Phytobia (Poëmyza) subangulata (Malloch), new combination

Agromyza subangulata Malloch, 1916, Psyche, 23:51.

Illinois.

6*d*. Subgenus *Icteromyza* Hendel

[Gr., *ikteros*, jaundice (yellowness); plus *myza*]

Icteromyza Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:51.

Type.—Agromyza geniculata Fallén, 1823, by original designation.

Of moderate size, 1.5 to 4 mm. in body length. Black or brown; frontal vitta shining, light yellow; fringe of calypters brown; halteres white or yellowish. Head with vertical triangle

slenderly elongate anteriorly, reaching lunule; frontal vitta narrow, as long or longer than wide; lunule wide, low; antennal bases rather widely separated. Antennae of males not enlarged. Larvae unknown.

NEW WORLD SPECIES IN THE GENUS *Phytobia* (*Icteromyza*)

Phytobia (Icteromyza) arctica (Lundbeck), new combination

Agromyza arctica Lundbeck, 1900, Vid. Medd., 5:304.

Dizygomyza (*Icteromyza*) *arctica* (Lundbeck): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:57.

Hendel placed this species as probably near *P. lineella* (Zetterstedt), 1840. Greenland.

Phytobia (Icteromyza) genualis (Melander), new combination

Agromyza genualis Melander, 1913, Jour. N. Y. Ent. Soc., 21:261; Malloch, 1918, Canad. Ent., 50:318.

Agromyza coloradensis Malloch, 1913, Ann. Ent. Soc. Amer., 6:297.

Three specimens in the California Academy of Sciences collection were from California and Ontario, Canada. Also recorded from Washington, Idaho, Montana, Colorado, Maine.

Phytobia (Icteromyza) longipennis (Loew), new combination

Agromyza longipennis Loew, 1869, Berl. ent. Zeitschr., 13:48; Melander, 1913, Jour. N. Y. Ent. Soc., 21:255; Malloch, 1913, Ann. Ent. Soc. Amer., 6:296; Malloch, 1934, Dipt. Patag. S. Chile, 6:478.

Dizygomyza (*Icteromyza*) *longipennis* (Loew): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:56.

Hendel questionably placed this species as a synonym of *P. lineella* (Zetterstedt), 1840. Chile, North America.

6*e*. Subgenus *Amauromyza* Hendel

[Gr., *amaurus*, dark; plus *myza*]

Amauromyza Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:59.

Type.—*Agromyza lamii* Kaltenbach, 1858, by original designation.

Of moderate size, 1.5 to 3 mm. in body length. Black or brown, sometimes tinged with grayish black; fringe of calypters dark; halteres with knobs partly to wholly brown or black. Head with lunule small, low; genovertical plates not prominent nor raised sharply above frontal vitta; 3 ifo; 2 or 3 sfo, only the posteriormost dorsally directed. Thorax bears no prsc setae. Wing with M_{1+2} ending at wing tip; ultimate section of M_{3+4} from 1.5 to several times as long as penultimate section. Larvae with anterior spiracles small, each bearing 8 or 9 bulbs; 3 subequal, moderately elongate bulbs in each of posterior spiracles; mining in stems and leaves of plants in families Chenopodiaceae and Labiatae. Closely related to subgenus *Phytobia*.

NEW WORLD SPECIES IN THE GENUS *Phytobia* (*Amauromyza*)

Phytobia (Amauromyza) abnormalis (Malloch), new combination

Agromyza abnormalis Malloch, 1913, Ann. Ent. Soc. Amer., 6:320.

Dizygomyza (*Amauromyza*) *abnormalis* (Malloch): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:59.

Originally described from adults reared from mined roots of *Amaranthus* sp. in Kansas, the species was later found in Europe, where the larvae mine the stems of *Chenopodium album* L. Europe, central United States.

Phytobia (Amauromyza) maculosa (Malloch), new combination

Agromyza setosa Coquillett, 1898 (*nec* Loew, 1869), Bull. Dept. Agric., Ent., 10:78.

Agromyza maculosa Malloch, 1913, Ann. Ent. Soc. Amer., 6:302; Frost, 1924, Cornell Mem., 78:45; Malloch, 1934, Dipt. Patag. S. Chile, 6:476.

Dizygomyza maculosa (Malloch): Blanchard, 1938, An. Soc. Cient. Argent., 126:358.

This species exhibits characters common to both *Phytobia* and *Amauromyza;* it is placed here because of the partly darkened knobs of the halteres. Like *Phytobia*, *P. maculosa* has 2 sfo setae, both dorsally directed; weak but differentiated prsc setae; ultimate section of M_{3+4} subequal to the penultimate; 2 strong setae centrally on mid-tibiae. In common with *Amauromyza* are: 3 ifo setae (variable in *Phytobia*); presutural ia seta absent; M_{1+2} at apex of wing; halteres with partly blackened knobs. The larvae mine the leaves of plants in the family Com-

positae. I have reared the species from large greenish-white blotch mines in the leaves of *Baccharis douglasii* D. C., *Artemisia vulgaris* L., *Erigeron canadensis* L., and cultivated *Aster* sp. Argentina, Uruguay, Bermuda, widespread throughout the United States.

Phytobia (Amauromyza) maculosa var. fuscibasis (Malloch), new combination

Agromyza maculosa var. *fuscibasis* Malloch, 1934, Dipt. Patag. S. Chile, 6:476.

Argentina.

6*f*. Subgenus *Calycomyza* Hendel

[Gr., *calykos*, calyx, cup; plus *myza*]

Calycomyza Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:65.

Redia Lioy, 1864 (*nec* Filippi, 1837, Trematoda), Atti Ist. Veneto, (3) 9:1313; Coquillett, 1910, Proc. U. S. Nat. Mus., 37:599. New synonymy.

Type.—*Agromyza artemisiae* Kaltenbach, 1856, by original designation.

Type of homonym and synonym.—*Redia: Agromyza gyrans* Fallén, 1823, by subsequent designation of Coquillett, 1910*b*.

Of moderate size, 1.5 to 3 mm. in body length. Black, shining; head mostly yellow; lateral margins of mesonotum widely yellow; legs entirely black; halteres white or yellowish. Head with lunule small; genovertical plates not prominent; genae narrow; antennal bases approximate. Thorax with 3 + 0 dc setae; prsc setae absent. Larvae with the number of bulbs in posterior spiracles variable; mining leaves of plants usually in families Campanulaceae, Malvaceae, and Compositae.

New World Species in the Genus *Phytobia* (*Calycomyza*)

Phytobia (Calycomyza) allecta (Melander), new combination

Agromyza lateralis Williston, 1896 (*nec* Macquart, 1835), Trans. Ent. Soc. London, 1896:428. Primary homonym.

Agromyza platyptera var. *allecta* Melander, 1913 (n.n. for *A. lateralis* Williston, 1896, *nec* Macquart, 1835), Jour. N. Y. Ent. Soc., 21:257.

Agromyza allecta Melander: Frost, 1924, Cornell Mem., 78:38.

Frost reared this species from mines in the leaves of *Arctium lappa* L., *Bidens frondosa* L., and *Eupatorium purpureum*. West Indies, New York, Pennsylvania, and New Jersey.

Phytobia (Calycomyza) artemisiae (Kaltenbach), new combination

Agromyza artemisiae Kaltenbach, 1856, Verh. naturh. Ver. preuss. Rheinl. und Westphal., 13:236.

Dizygomyza (*Calycomyza*) *artemisiae* (Kaltenbach): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:66.

Agromyza atripes Zetterstedt, 1860, Dipt. Scand., 14:6461.

Agromyza minuta Strobl, 1880 (*nec* Meigen, 1838), Obergymnasiums Benedikt., Programm, 14:37.

I received a pair of *P. artemisiae* from Dr. Hering to compare with specimens reared from large, greenish blotch mines in the leaves of *Artemisia vulgaris* L. in California. The larvae of this relatively large species mine the leaves of *Artemisia vulgaris* and *Eupatorium cannabinum* L. in Europe. Europe and probably widespread in North America.

Phytobia (Calycomyza) cassiae (Frost), new combination

Agromyza cassiae Frost, 1936, Ann. Ent. Soc. Amer., 29:306.

Closely related to *P. allecta* (Melander) (Frost, 1936). The larvae mine the leaves of *Cassia bacillaris* L., *Malvastrum coromendelianum* Garcke, and *Sauvia* sp. Canal Zone, Costa Rica.

Phytobia (Calycomyza) humeralis (von Roser), new combination

Agromyza humeralis von Roser, 1840, Korresp.-Bl. wuertt. landw. Ver., 8:63.

Dizygomyza (*Calycomyza*) *humeralis* (von Roser): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:68; Hendel, 1936, *in* Lindner: Die Flieg. palaearkt. Reg., 59:562.

Agromyza bellidis Kaltenbach, 1858, Verh. naturh. Ver. preuss. Rheinl. und Westphal., 15:82.

Agromyza coronata Loew, 1869, Berl. ent. Zeitschr., 13:48.

Dr. Hering confirmed that specimens of *P. coronata* sent to him were identical with *P. humeralis*. I have reared this species from blotch mines in the leaves of *Erigeron canadensis* L., *Heterotheca grandiflora* Nutt., *Baccharis douglasii* D. C., *Madia elegans* Don., *Aster chilensis* Nees, cultivated *Aster* sp., and cultivated *Zinnia* sp. Central Europe, widespread in North America.

Phytobia (Calycomyza) ipomaeae (Frost), new combination

Agromyza ipomaeae Frost, 1931, Ent. News, 42:74.

The larvae mine the leaves of sweet potato. Puerto Rico.

Phytobia (Calycomyza) jucunda (van der Wulp), new combination

Agromyza jucunda van der Wulp, 1867, Tijdschr. Ent., 10:161.

Dizygomyza jucunda (van der Wulp): Blanchard, 1938, An. Soc. Cient. Argent., 126:358.

? *Agromyza platyptera* Thomson, 1868, Dipt. Freg. Eugen. Resa, (2) 6 (12):608; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:67.

Oscinis malvae Burgess, 1880, Ann. Rept. U. S. Dept. Agric., 1879:202; Coquillett, 1898, Bull. Dept. Agric., Ent., 10:77.

Dr. Hering, in correspondence, has confirmed that this species does not occur in Europe. It is very closely related to *P. humeralis*, but the larvae make distinctive blotch mines in the leaves of numerous plants. Hendel believed that *A. platyptera* is probably a synonym of *P. jucunda*. The type of the former is apparently lost. I have reared this species from *Artemisia vulgaris* L., *Helianthus annuus* L., *Heterotheca grandiflora* Nutt., and *Aster chilensis* Nees. Argentina, probably widespread in North America.

Phytobia (Calycomyza) meridiana (Hendel), new combination

Agromyza meridionalis Malloch, 1914 (*nec* Strobl, 1900), Trans. Amer. Ent. Soc., 40:35. Primary homonym.

Agromyza meridiana Hendel, 1923 (n.n. for *A. meridionalis* Malloch, 1914, *nec* Strobl, 1900), Konowia, 2:145.

Costa Rica.

6*g*. Subgenus *Trilobomyza* Hendel

[Gr., *tri*, three; plus *lobus*, lobe; plus *myza*]

Trilobomyza Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:71.

Type.—Agromyza flavifrons Meigen, 1830, by original designation.

Of moderate size, 2 to 3 mm. in body length. Blackish; frontal vitta usually yellow, if brownish yellow, then abdomen concolorous. Head with lunule not more than half height of frontal vitta, semicircular in outline; genovertical plates not prominent, not sharply raised above frontal vitta. Larvae with 3 stigmatal openings in each of posterior spiracles; mining leaves of plants in families Caryphyllaceae, Labiatae, and Scrophulariaceae.

This small group contains three European species. No North American species can be definitely placed here.

6*h*. Subgenus *Praspedomyza* Hendel

[Gr., *prason*, leek; plus *pedis*, foot; plus *myza;* derivation uncertain]

Praspedomyza Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:77.

Type.—Dizygomyza approximata Hendel, 1920, by original designation.

Of moderate size, 1.5 to 2.5 mm. in body length. Black or brown, variably marked with yellow; halteres white or yellowish. Head with genae about half (or less than half) eye height; lunule small, low; genovertical plates prominent, sharply raised above frontal vitta; antennal bases approximate. Thorax with 3 + 1 dc setae; prsc setae absent. Larvae with many bulbs in posterior spiracles, mining leaves of plants in families Rubiaceae and Theymelacaceae.

In this subgenus, Hendel (1931*b*) placed *Phytobia hilarella* (Zetterstedt), 1848, a diverse species the larvae of which mine the fronds of *Pteris aquilina* L. in Europe.

New World Species in the Genus *Phytobia* (*Praspedomyza*)

Phytobia (Praspedomyza) clara (Melander), new combination

Agromyza clara Melander, 1913, Jour. N. Y. Ent. Soc., 21:265; Frost, 1924, Cornell Mem., 78:41.

Agromyza citreifrons Malloch, 1913, Ann. Ent. Soc. Amer., 6:290; Malloch, 1918, Canad. Ent., 50:316. New synonymy.

A study of two paratypes of *A. citreifrons* places it as a synonym of *A. clara*. This species is very closely related to *P. hilarella*. Hering in correspondence mentioned that frond specimens of *Pteris aquilina* L. sent to him had mines identical to those made by *P. hilarella*, but that the adults of the two species had some color differences. My specimens do not agree entirely with the description of *P. hilarella* given by Hendel (1931*b*), although the two species are very closely related.

Frost (1924) notes that Aldrich identified as this species the one in which the larvae mine the leaves of *Catalpa bungei*. I have reared the species from mines in the fronds of *Pteris aquilina* L. in California and have compared them with Melander's type. California, Idaho, Ohio, Pennsylvania, Maine.

6*i*. Subgenus *Dizygomyza* Hendel

[Gr., *dis*, twice, doubly; plus *zigon*, yoke, collar; plus *myza*; derivation uncertain]

Dizygomyza Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:83.

Type.—Agromyza morosa Meigen, 1830, by original designation.

Of moderate size, 1.5 to 2.5 mm. in body length. Black or brown; frontal vitta dark, opaque; anepisternum narrowly yellow dorsally; posterior margins of abdominal segments sometimes narrowly yellow; halteres white or yellowish. Head with frontal vitta broad, sides parallel, wider than long; vertical triangle not produced anteriorly; lunule broad, low; antennal bases rather widely separated. Third antennal segment of males enlarged, sometimes greatly so. Larvae with elongate, corneous, acuminate, variously curved bulbs in posterior spiracles; mining in leaves of monocotyledonous plants.

New World Species in the Genus *Phytobia* (*Dizygomyza*)

Phytobia (Dizygomyza) luctuosa (Meigen), new combination

Agromyza luctuosa Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:182.

Dizygomyza (*Dizygomyza*) *luctuosa* (Meigen): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:88.

Agromyza grossicornis Zetterstedt, 1860, Dipt. Scand., 14:6456; Melander, 1913, Jour. N. Y. Ent. Soc., 21:256.

Phyllomyza flavocincta Strobl, 1880, Obergymnasiums Benedikt., Programm, 14:37.

Dizygomyza effusi Karl, 1926, Stettin. ent. Ztg., 87:136.

The synonymy given above is taken from Hendel (1931*b*). Melander has specimens of *A. grossicornis* from Strobl. Widespread in Europe, North Africa, and North America.

Phytobia (Dizygomyza) magnicornis (Loew), new combination

Agromyza magnicornis Loew, 1869, Berl. ent. Zeitschr., 13:46; Melander, 1913, Jour. N. Y. Ent. Soc., 21:256; Malloch, 1913, Ann. Ent. Soc. Amer., 6:300.

Dizygomyza (*Dizygomyza*) *magnicornis* (Loew): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:84.

This species was synonymized with *A. laterella* of Malloch by Malloch and with *A. grossicornis* by Melander. Hendel believed it to be close to *P. morosa* (Meigen). Washington, Wisconsin, and Illinois.

Phytobia (Dizygomyza) marginata (Loew), new combination

Agromyza marginata Loew, 1869, Berl. ent. Zeitschr., 13:49; Melander, 1913, Jour. N. Y. Ent. Soc., 21:256; Malloch, 1913, Ann. Ent. Soc. Amer., 6:298.

Illinois, Indiana, Massachusetts, Washington, D.C.

Phytobia (Dizygomyza) thompsoni Frick, new name

Agromyza magnicornis Coquillett, 1907 (*nec* Loew, 1869), *in* Thompson, 1907, Psyche, 14:71.

Agromyza laterella Malloch, 1913 (*nec* Zetterstedt, 1840), Ann. Ent. Soc. Amer., 6:300; Claasen, 1918, Ann. Ent. Soc. Amer., 11:9; Frost, 1924, Cornell Mem., 78:44.

Dizygomyza (*Dizygomyza*) *laterella* (Malloch): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:84.

This species requires a new name. It is here named in honor of Mr. M. T. Thompson, who first described the damage caused by the larvae to iris leaves. Hendel states that this species is probably either *P. morosa* (Meigen) or one of the very closely related iris-mining species of Europe. Widespread in North America.

NEW WORLD SPECIES IN THE GENUS *Phytobia* OF UNCERTAIN SUBGENERIC POSITION

Phytobia (? subgenus) correntosana (Malloch), new combination

Agromyza correntosana Malloch, 1934, Dipt. Patag. S. Chile, 6:478.

Argentina.

Phytobia (? subgenus) indecisa (Malloch), new combination

Agromyza indecisa Malloch, 1913, Ann. Ent. Soc. Amer., 6:292.

Malloch states that this species is closely related to *Phytobia clara* (Melander). New Mexico.

Phytobia (? subgenus) nitidiventris (Malloch), new combination

Agromyza nitidiventris Malloch, 1934, Dipt. Patag. S. Chile, 6:477.

Argentina.

Phytobia (? subgenus) peullae (Malloch), new combination

Agromyza puellae Malloch, 1934, Dipt. Patag. S. Chile, 6:476; Ortiz, 1946, Cat. Dipt. Chile, p. 141.

Argentina, Chile.

Phytobia (? subgenus) varia (Melander), new combination

Agromyza varia Melander, 1913, Jour. N. Y. Ent. Soc., 21:264.

Although the knob of the halteres is black, the coloration precludes this species' belonging in the subgenus *Amauromyza*. Idaho.

7. Genus *Cerodontha* Rondani

[Gr., *keras*, horn; plus *odontos*, tooth]

Cerodontha Rondani, 1861 (n.n. for *Odontocera* Macquart, 1835, *nec* Serville, 1833), Dipt. Ital. Prod., 4:10; Lioy, 1864, Atti Ist. Veneto, (3) 9:1314; Hendel, 1910, Wien. ent. Ztg., 29:313 (as *Cerodonta*); Coquillett, 1911, Wien. ent. Ztg., 30:64; Melander, 1913, Jour. N. Y. Ent. Soc., 21:249; Malloch, 1913, Ann. Ent. Soc. Amer., 6:331; Hendel, 1920, Arch. Naturgesch., Abt. A., 84:168; de Meijere, 1926, Tijdschr. Ent., 69:300; Hering, 1927, Tierw. Deutschl., 6:157; Hendel, 1932, *in* Lindner: Die Flieg. palaearkt. Reg., 59:265; Venturi, 1946, Redia, 31:191.

Odontocera Macquart, 1835 (*nec* Serville, 1833, Coleoptera), Hist. Nat. Insect., Dipt., 2:614; Westwood, 1840, Modern Class. Insects, Gen. Syn., 2:151; Rondani, 1856, Dipt. Ital. Prod., 1:127; Rondani, 1861, Dipt. Ital. Prod., 4:10 (as *Odonthocera*).

Ceratomyza Schiner, 1862 (n.n. for *Odontocera* Macquart, 1835, *nec* Serville, 1833), Wien. ent. Monatschr., 6:434; Aldrich, 1905, Smithson. Misc. Coll., 46:647; Becker *et al.*, 1905, Kat. palaearkt. Dipt., 4:250.

Micromma Philippi, 1865, Verh. zool.-bot. Ges. Wien., 15:777; Malloch, 1934, Dipt. Patag. S. Chile, 6:484.

Triticomyza Blanchard, 1938, An. Soc. Cient. Argent., 126:358.

Type.—*Chlorops denticornis* Panzer, 1806, *ipso facto.*

Types of homonym and synonyms.—*Odontocera: Chlorops denticornis* Panzer, 1806, by original designation of Macquart, 1835; *Ceratomyza: Chlorops denticornis* Panzer, 1806, *ipso facto; Micromma: Micromma flavifrons* Philippi, 1865, monobasic; *Triticomyza: Triticomyza cruciata* Blanchard, 1938, monobasic.

Adult.—Relatively elongate, of moderate size, 1.5 to 4 mm. in body length. Black with yellowish markings; wings hyaline; halteres whitish or yellowish.

Head: As viewed laterally, usually subtriangular, projecting anteriorly dorsad of antennae. Mesofacial plate broad, flattened; frontal vitta usually broader than long; ptilinal fissure inconspicuous. Proboscis short. Antennal bases slightly separated; third segment elongate, with a clawlike apex, or drawn out to an acute angle, or bearing a sharp spine; arista situated somewhat basally. Setae: vi well developed; 1 to 3 ifo, usually 2, anteriormost sometimes minute; 2 sfo; os rather sparse, erect or dorsally directed.

Setal pattern of thorax: 1 h; 1 prs; 1 sa; 1 ia; 1 or 2 pa, the inner, when present, minute; 3 + 1 dc; 0 prsc; acr absent or in 2 to 6 or 7 rows, posteriorly ending at first pair of dc; 2 sc; 1 pp; 1, the posterior, or 2 npl; 1 aes; 1 kes.

Wing (fig. 22): Costa usually reaching M_{1+2} (between R_{4+5} and M_{1+2} in 1 species); m-m usually present.

Male terminalia: Aedeagal apodeme extending posteriorly within ninth tergite; epiphallus moderately elongate, curved, sharp at tip; aedegal hood moderately extending anteriorly, narrow. Phallophore greatly elongate anteriorly, closely united to aedeagal apodeme; portion bearing phallus moderately long, a nearly closed tube. Phallus long, slender; basal section long, a nearly closed tube, formed by broad and partly united sclerites, ventral processes distinct; median section nearly as long as basal section, tubular, bearing a pair of posteriorly directed ventral processes; distal section very long, sigmaform, composed of two approximate slender tubes each bearing distally a knob which is sometimes expanded. Ninth sternite with very little vertical curvature, posterior arms slightly dorsally curved; sidepieces very broad or slender, flattened; hypandrial apodeme absent. Pregonites composed of subtriangular plates each bearing a pair of sensory pores; extending dorsally to a slight degree. Postgonites with outer process curving strongly posteriorly from anteriorly produced phallophore; inner process short; ventral process extending ventrad of ninth tergite, not broadened, curved inward, terminating in 2 or 3 blunt teeth. Ninth tergite, viewed in profile, broader ventrally; articulated to ninth sternite about midway between dorsal and ventral margins; ventral margin curved strongly inward and dorsally and bearing posteriorly numerous fine setae and blunt short spines; at posteroventral angles a rounded lobe present; anteroventral angles drawn out sharply anteriorly. Surstyli borne dorsally within ninth tergite; elongate, relatively slender, extending ventrad of ninth tergite, terminating bluntly, without spines. Bacilliform sclerites arching dorsally from ninth sternite to dorsal limits of surstyli, then broadening and extending ventrally to cerci. Cerci small; not flattened, broadened centrally or ventrally. Ejaculatory apodeme large; base not broadened at right angles to plane of blade, elongate in plane of blade, curving round to support elongate bulb; stem short, broad; blade moderately expanded.

Larva.—Relatively slender, long, about 4 mm. in length. Shining white, sometimes pale yellow on anterior half of body.

Head: Mandibles subtriangular, short, broadened basally; terminal pair of teeth more removed from each other than the posterior pair, which are approximate. Paraclypeal phragma relatively long, dorsally almost in a straight line with labial sclerite; dorsal process moderately widened; ventral somewhat shorter. Usually a group of minute dark setulae dorsad of antennae; usually an area of triangular tubercles laterally, ventrad of mandibles.

Body: Anterior spiracles relatively large, palmately lobed, each with 2 to 6 lobes and bearing 5 to 15 bulbs. Abdominal cuticular processes on abdominal segments 1 to 7 small, short; in a wide inconspicuous band, no processes centrally; anterior portion of bands narrow, posterior portion wide. Posterior spiracles rather long, palmately lobed, each with 3 to 6 irregular lobes and bearing 5 to 15 bulbs. Posterior end truncate, tubercles or lobes absent.

Macquart erected *Odontocera* to include *Chlorops denticornis* Panzer, as the type, which had been placed in *Agromyza* by Meigen (1830), *Agromyza affinis* Fallén, 1823, and *O. spinicornis*, n. sp. (synonym of *A. fulvipes* Meigen, 1830).

Rondani (1861), in proposing a new name for *Odontocera*, spelled it *Odonthocera* and proposed *Cerodontha* by reversing the two syllables of the original. Hendel (1910), in resurrecting the name, used the spelling *Cerodonta*. Coquillett (1911) pointed out that the original spelling should be retained.

Philippi (1865) questionably placed *flavifrons*, n. sp., in the genus *Dolicopus*. He felt that the species probably represented a new genus, and suggested the name *Micromma*. Malloch (1934*a*) placed the species in *Cerodontha*.

This is a small genus, with only ten Palaearctic species known in 1932, and but one has been added since. A single species is known from North America and four or possibly five from South America.

NEW WORLD SPECIES IN THE GENUS CERODONTHA

Cerodontha cruciata (Blanchard), new combination

Triticomyza cruciata Blanchard, 1938, An. Soc. Cient. Argent., 126:356.

The description shows that this species belongs here. Although cross vein m-m is absent (as it is in one European species), the third antennal segment is subquadrate and is produced into a spine distally on the dorsal angle, and the larvae mine the leaves of wheat. Argentina.

Cerodontha denticornis (Panzer)

Chlorops denticornis Panzer, 1806, Fauna German., No. 104, fig. 22.

Cerodontha denticornis (Panzer): Lioy, 1864, Atti Ist. Veneto, (3) 9:1315; Malloch, 1934, Dipt. Patag. S. Chile, 6:485; Blanchard, 1938, An. Soc. Cient. Argent., 126:358.

The Neotropical records of this Palearctic species may possibly be misidentifications of *C. dorsalis* (Loew). Argentina.

Cerodontha dorsalis (Loew)

Odontocera dorsalis Loew, 1863, Berl. ent. Zeitschr., 7:54.

Cerodontha dorsalis (Loew): Melander, 1913, Jour. N. Y. Ent. Soc., 21:249; Malloch, 1913, Ann. Ent. Soc. Amer., 6:331; Hendel, 1932, *in* Lindner: Die Flieg. palaearkt. Reg., 59:269; Curran, 1934, Proc. Calif. Acad. Sci., (4)21(13):163; Frost, 1936, Ann. Ent. Soc. Amer., 29:318; Wolcott, 1936, Jour. Agric. Univ. Puerto Rico, 20:391; Venturi, 1946, Redia, 31:213.

Cerodontha femoralis Melander, 1913 (*nec* Meigen, 1838), Jour. N. Y. Ent. Soc., 21:249; Aldrich, 1918, Ann. Ent. Soc. Amer., 11:63.

Aldrich (1918) synonymized *C. femoralis* of Melander as the result of extensive and widespread collections. Terminalia studies have confirmed that this species is but a color phase of the darker *C. dorsalis.* Hendel, not having specimens of *C. dorsalis,* synonymized it with *C. denticornis,* a very similar species. The terminalia of *C. dorsalis* differ markedly from those of *C. denticornis.* The distinctness of *C. dorsalis* was previously suggested by Venturi (1946) because of the biological differences between the species. Certain external characters have been found with which to separate the two species; these follow:

Adult.—Head with gena about one-third eye height (about half in *C. denticornis*); third antennal segment not truncate distally, dorsal angle slightly produced (truncate, subquadrate in *C. denticornis*); upper ifo seta 4 times as long as lower (8 times in *C. denticornis*); lower ifo seta 1.5 times as long as an os seta (subequal in *C. denticornis*). Thorax with ia seta one-third to less than half the length of first dc (one-half or more in *C. denticornis*); no setulae in ia row opposite second dc (1 setula in *C. denticornis*). Wing with cross vein m-m 1.3 to 1.4 times its length from r-m (1.6 in *C. denticornis*); ultimate section of M_{1+2} about 4.9 times as long as penultimate section (5.8 in *C. denticornis*); ultimate section of M_{3+4} about 1.9 times as long as penultimate section (1.2 in *C. denticornis*).

A specimen in the California Academy of Sciences collection from the Galapagos Islands (Curran, 1934*b*) is atypical and appears to represent a different species. The larvae of this species are grass miners. Guatemala, Puerto Rico, ? Galapagos Islands, and widespread throughout North America.

Cerodontha flavifrons (Philippi)

Micromma flavifrons Philippi, 1865, Verh. zool.-bot. Ges. Wien., 15:777.

Cerodontha flavifrons (Philippi): Malloch, 1934, Dipt. Patag. S. Chile, 6:484; Ortiz, 1946, Cat. Dipt. Chile, p. 141.

Philippi placed this species questionably under *Dolicopus* and noted that the species was atypical and possibly represented a new genus, for which he suggested the name *Micromma.* Chile.

Cerodontha fulvithorax Malloch

Cerodontha fulvithorax Malloch, 1934, Dipt. Patag. S. Chile, 6:484.

Argentina.

Cerodontha nigricornis Becker

Cerodontha nigricornis Becker, 1919, Mis. Arc Mérid. Amér. Sud., 10:212.

Ecuador.

8. Genus *Liriomyza* Mik

[Gr., *lirion,* lily; plus *myza*]

Liriomyza Mik, 1894, Wien. ent. Zeitung, 13:284; Hendel, 1920, Arch. Naturgesch., Abt. A., 84:139; de Meijere, 1925, Tijdschr. Ent., 68:271; Hendel, 1927, Zool. Anz., 69:250; Hering, 1927, Tierw. Deutschl., 6:59; Malloch, 1927, Proc. Linn. Soc. N.S.W., 52:426; Hendel, 1931,

in Lindner: Die Flieg. palaearkt. Reg., 59:197; Enderlein, 1936, Tierw. Mitteleur., 6 (3):180; de Meijere, 1937, Tijdschr. Ent., 80:194.

Agrophila Lioy, 1864 (*nec* Boisduval, 1840, Noctuidae, Lepidoptera), Atti Ist. Veneto, (3) 9:1314; Coquillett, 1910, Proc. U. S. Nat. Mus., 37:504. New synonymy.

Type.—*Liriomyza urophorina* Mik, 1894, monobasic.

Type of synonym.—*Agrophila: Agromyza strigata* Meigen, 1830 (as *A. exilis* Meigen, 1830), by subsequent designation of Coquillett, 1910*b*.

Adult.—Of moderate size, rather robust, 1 to 2.5 mm. in body length. Seventh segment of female abdomen sometimes large, conspicuous; nearly equaling abdominal length in type. Shining black and yellow, rarely opaque; mesonotum mostly black, sometimes yellow anterior to scutellum extending to second pair of dc; scutellum with a longitudinal yellow band on dorsum; head, humeri, and pleurae partly yellow; seventh segment of female abdomen black; legs usually yellow, rarely entirely black; halteres whitish or yellow; wings usually hyaline, sometimes faintly tinged with brown.

Head: Genae usually moderately elongated ventrally; frontal vitta slightly longer than broad; upper mesofacial plate and lunule usually deeply sunken below genovertical plates and frontal vitta in dried specimens, not so in fresh material. Antennal bases approximate; third segment usually rounded at apex, sometimes forming a blunt dorsal angle, rarely terminating in a sharp point; arista often swollen near base, slender distally. Proboscis short. Setae: vi well developed; 1, rarely, 2 or 3 ifo; 1, rarely, or 2 sfo; os usually numerous, often moderately long, erect or dorsally directed.

Setal pattern of thorax: 1 h; 1 prs; 1 sa; 0 or 1 ia, when present the ia is usually no larger than an acr, rarely twice as large, never prominent; 1 or 2 pa; 3 + 1 dc; 0 prsc; 2 to 6 rows of acr, becoming sparser posteriorly, usually ending between first or second pair of dc, rarely absent; 1 pp; 2 npl; 1 aes; 1 kes.

Wing (fig. 23): Costa reaching M_{1+2}; m-m usually present, very rarely absent; Cu + Pl rather strong at base, outwardly becoming a fold, never reaching wing margin.

Male terminalia: Aedeagal apodeme extending posteriorly within ninth tergite; epiphallus moderately large, terminating bluntly posteriorly, very slightly curved; aedeagal hood small, relatively broad, somewhat widening anteriorly, not elongate anteriorly but sometimes slightly more so laterally. Phallophore small, slightly extending anteriorly along aedeagal apodeme; portion bearing phallus relatively short, tubular. Phallus of moderate size; basal section moderately long, tubular, two sclerites very broad, ventral processes slender, short; median section very short, tubular, ventral processes very short, discernible with difficulty; distal section expanded, tubular, constricted near middle, somewhat curved dorsally. Ninth sternite gently curved vertically, anterior end curved dorsally, and slightly so posteriorly; sidepieces slender, broadly curved anteriorly, rarely with short ventral processes. Pregonites broadly united to ninth sternite; extending somewhat ventrally, not dorsally, approximate centrally; without sensory pores or setae. Postgonites with outer process minute; inner process broadly united with ventral portion, forming a nearly straight piece; ventrally a little broadened, rounded. Ninth tergite subrectangular, as viewed laterally, angles quite distinct, somewhat broader ventrally; ventral margin straight, not turned inward; a heavy short spine on each posterolateral angle; articulated to ninth sternite very near the ventral margin. Surstyli on anterolateral angles; completely separated from ninth tergite by a suture; somewhat elongate, directed inward; distally usually bearing one or a few teeth curving inward, dorsally, or posteriorly; distally rather narrowly united to bacilliform sclerites. Bacilliform sclerites moderately long, inconspicuous, sometimes broadened, rather narrowly united by membrane posteriorly. Cerci moderately large, slender, not flattened. Ejaculatory apodeme with base relatively small, sometimes narrowly curved to enclose part of bulb; stem long, slender; blade with outer angles usually rounded, narrowly to broadly expanded.

Larva.—Of moderate size, 2 to slightly more than 3 mm. in length. Glistening white, usually bright yellow on anterior half of body.

Head: Mandibles usually strong and long; terminal tooth the stronger, median tooth of each separated from terminal one; alternating, the teeth appearing to be 4 in number in lateral view. Paraclypeal phragma with dorsal arm of dorsal process slender; ventral process shorter. Sometimes a patch of short setulae dorsad of antennae.

Body: Anterior spiracles small; knoblike or divided into 2 short lobes. Abdominal cuticular processes small, usually subequal. Posterior spiracles usually with 2 or 3 equal lobes, one sometimes elongate, but never more than twice as long as the other lobes; 8 to 14 bulbs, sometimes with 3, rarely with many bulbs. Posterior end truncate, often with a distinct lateral lobe situated slightly ventrad of mid-line on each side; without tubercles; anal lobes slightly enlarged, rounded.

Liriomyza was erected for *urophorina*, n. sp., which has the basal segment of the female ovipositor nearly as long as the abdomen. As the larvae of this species mine in the flowers of *Lilium martagon* L., the ovipositor may be elongated to accomplish deposition of the eggs in the flowers. Melander (1913) tentatively placed *tubifer*, n. sp., in *Liriomyza*, noting that, aside from the large seventh segment, this species would be merely a color variation of *Agromyza melampyga* Loew. Aside from the basal segment of the ovipositor the species included in *Liriomyza* form a very homogeneous group, differing but little in coloration and structure from the type.

Lioy (1864) erected *Agrophila* for four of Meigen's species (no. 64, *Agromyza exilis;* no. 65, *A. orbona;* no. 68, *A. amoena;* and no. 69, *A. blanda*) which he separated on the basis of the abdomen's being oval in outline. *Haplomyza* and *Metopomyza* were removed from *Liriomyza* by Enderlein (1936*a*).

Liriomyza is a large genus; Hendel (1931*d*) defined seventy-eight Palearctic species, and fourteen new species have been described since that time. The North American fauna contains numerous species referable to *Liriomyza.*

Certain European species have been recorded in North America that have subsequently been shown to have been misidentifications. These species, formerly in *Agromyza* s.l., are *Liriomyza orbona* (Meigen), 1830, *L. pascuum* (Meigen), 1838, *L. puella* (Meigen), 1830, *L. variegata* (Meigen), 1830, and *L. scutellata* (Panzer), 1809. North American specimens of *A. orbona* (Melander, 1913; Frost, 1943) have recently been found to be distinct, and in another publication the species is described as new. Melander's specimens (1913) of *A. pascuum, A. puella,* and *A. variegata* do not agree with the European material obtained from Strobl. Fallén used the name *scutellata* for specimens of *Chlorops scutellatus* Panzer, 1809. Hendel (1936) placed the species in the family Chloropidae, and the name is no longer valid in Agromyzidae.

New World Species in the Genus Liriomyza

Liriomyza allia (Frost), new combination

Agromyza allia Frost, 1943, Jour. N. Y. Ent. Soc., 51:257.

The larvae make linear mines in onion leaves. Iowa, Kansas, Michigan, Missouri.

Liriomyza americana (Schiner), new combination

Agromyza americana Schiner, 1868, Reise Freg. Novara, Zool., Dipt., 2:290.

The species has never been mentioned since it was described; the description appears to place it in *Liriomyza.* South America.

Liriomyza andina (Malloch), new combination

Agromyza andina Malloch, 1934, Dipt. Patag. S. Chile, 6:471; Ortiz, 1946, Cat. Dipt. Chile, p. 141.

Chile.

Liriomyza angulicornis (Malloch)

Agromyza angulicornis Malloch, 1918, Canad. Ent., 50:79; Malloch, 1924, Canad. Ent., 56:192.

Liriomyza angulicornis (Malloch): Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:208.

Liriomyza angularis Hendel, 1920, Arch. Naturgesch., Abt. A., 84:140.

Originally described from Illinois, Hendel subsequently recorded it from Germany.

Liriomyza assimilis (Malloch), new combination

Agromyza assimilis Malloch, 1918, Canad. Ent., 50:80.

Illinois.

Liriomyza baptisiae (Frost), new combination

Agromyza baptisiae Frost, 1931, Canad. Ent., 63:275.

The larvae mine the leaves of *Baptisia tinctoria* (L). Pennsylvania.

Liriomyza barrocoloradensis (Frost), new combination

Agromyza barrocoloradensis Frost, 1936, Ann. Ent. Soc. Amer., 29:301.

Closely related to *L. borealis* (Malloch). The larvae are leaf miners, host plant unknown. Canal Zone.

Liriomyza borealis (Malloch), new combination

Agromyza borealis Malloch, 1913, Ann. Ent. Soc. Amer., 6:280; Frost, 1924, Cornell Mem., 78:40.

Frost records the larvae's mining the leaves of *Impatiens biflora* and *I. pallida*. British Columbia.

Liriomyza brassicae (Riley), new combination

Oscinis brassicae Riley, 1884, Ann. Rept. U. S. Dept. Agric., 1884:322.

Agromyza brassicae (Riley): Coquillett, 1898, Bull. Dept. Agric., Ent., 10:78; Melander, 1913, Jour. N. Y. Ent. Soc., 21:258; Malloch, 1913, Ann. Ent. Soc. Amer., 6:278; Frost, 1924, Cornell Mem., 78:51.

? *Agromyza pascuum* Melander, 1913 (*nec* Meigen, 1838), Jour. N. Y. Ent. Soc., 21:258.

Liriomyza cruciferarum Hering, 1927, Zool. Jahrb., Abt. Syst., 53:461; de Meijere, 1928, Tijdschr. Ent., 71:160; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:215. New synonymy.

This species has been synonymized with *Agromyza pusilla* Meigen (Malloch, 1913*a*, Frost, 1924), *A. pascuum* Meigen (Melander, 1913), *A.* (*Phytomyza*) *diminuta* (Walker) (Coquillett, 1898), and tentatively with *L. cruciferarum* (Hendel, 1931*d*). Mr. C. W. Sabrosky compared specimens from my collection with the type in the United States National Museum and sent me a homotype female, reared from cabbage, to study. Specimens of *L. cruciferarum* sent by Dr. Hering were identical with the homotype female of *L. brassicae*. As a result of these studies, *L. brassicae* is considered a valid species. I have reared it from serpentine mines in the leaves of *Tropaeolum* sp. (Nasturtium), *Brassica oleracea* var. *botrytis*, *B. arvensis* (L.), *B. nigra* Koch, *Raphanus sativus* L., *R. sativus* var. *longipinnatus*. Central Europe, Canary Islands, North America.

Liriomyza braziliensis (Frost), new combination

Agromyza braziliensis Frost, 1939, Ent. News, 50:97; Mendes, 1940, Bol. Tec. Inst. Agron., Campinas, 78:207.

The larvae mine beneath the skin of potato tubers. Brazil.

Liriomyza chilensis (Malloch), new combination

Agromyza chilensis Malloch, 1934, Dipt. Patag. S. Chile, 6:469; Ortiz, 1946, Cat. Dipt. Chile, p. 141.

Chile.

Liriomyza commelinae (Frost), new combination

Agromyza commelinae Frost, 1931, Ent. News, 42:72.

Peculiar in having the male antennae greatly enlarged. The larvae mine the leaves of *Commelina virginica* and *C. nudiflora*. St. Vincent in British West Indies, Cuba.

Liriomyza cucumifoliae Blanchard

Liriomyza cucumifoliae Blanchard, 1938, An. Soc. Cient. Argent., 126:352.

The larvae mine the leaves of cultivated melons. Argentina.

Liriomyza discalis (Malloch), new combination

Agromyza discalis Malloch, 1913, Ann. Ent. Soc. Amer., 6:277.

Arizona.

Liriomyza diversa (Johnson), new combination

Agromyza diversa Johnson, 1922, Occ. Pap. Bost. Soc. Nat. Hist., 5:26.

Massachusetts, Vermont.

This species belongs under *Agromyza*, according to my later studies.

Liriomyza ecuadorensis (Frost), new combination

Agromyza ecuadorensis Frost, 1939, Ent. News, 50:99.

Ecuador.

Liriomyza felti (Malloch), new combination

Agromyza melampyga Felt, 1911 (*nec* Loew, 1869), N. Y. Mus. Bull., 147:67.

Agromyza felti Malloch, 1914, Ent. News, 25:310; Frost, 1924, Cornell Mem., 78:43.

The larvae form blotch mines in the leaves of *Camptosorus rhizophyllus* and *Asplenium pinnatifidum* and pupate at the ends of the mines. Illinois, New York.

Liriomyza flaveola (Fallén)

Agromyza flaveola Fallén, 1823, Dipt. Suec., Agromyzid., 2 (37):6; Frost, 1943, Jour. N. Y. Ent. Soc., 51:254.

Liriomyza flaveola (Fallén): Hendel, 1920, Arch. Naturgesch., Abt. A., 84:142; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:219.

Agromyza variegata Meigen, 1838 (*nec* Meigen, 1830), Syst. Beschr. bekann. eur. zweifl. Insekt., 7:402.

? *Agromyza pictella* Thomson, 1868, Dipt. Freg. Eugen. Resa, (2) 6 (12):609; Melander, 1913, Jour. N. Y. Ent. Soc., 21:258; Malloch, 1913, Ann. Ent. Soc. Amer., 6:280.

? *Agromyza scutellata* Malloch, 1913 (*nec* Fallén, 1823), Ann. Ent. Soc. Amer., 6:280.

Melander placed *A. pictella* as a synonym of *L. puella,* whereas Malloch synonymized it with *A. scutellata* of Malloch. Malloch also synonymized *A. flaveola* with his *A. scutellata.* Hendel questionably placed *A. scutellata* of Malloch as a synonym of *L. flaveola* because Malloch followed the earlier European workers in considering *A. flaveola* only a synonym of *A. scutellata.* I have reared *L. flaveola* from the grasses *Hordeum murinum* L., *Lolium multiflorum* Lam., and *Bromus carinatus* H. and A. in California. Europe, California and Arizona.

Liriomyza flavonigra (Coquillett), new combination

Agromyza flavonigra Coquillett, 1902, Jour. N. Y. Ent. Soc., 10:189; Melander, 1913, Jour. N. Y. Ent. Soc., 21:258; Malloch, 1913, Ann. Ent. Soc. Amer., 6:281.

New Mexico, New York.

Liriomyza fumicosta (Malloch), new combination

Agromyza fumicosta Malloch, 1914, Ent. News, 25:310.

Illinois.

Liriomyza gayi (Porter), new combination

Agromyza gayi Porter, 1915, Bol. Mus. Nac. Chile, 8:56; Malloch, 1934, Dipt. Patag. S. Chile, 6:472; Ortiz, 1946, Cat. Dipt. Chile, p. 141.

Chile.

Liriomyza holti (Malloch), new combination

Agromyza holti Malloch, 1924, Canad. Ent., 56:191; Frost, 1943, Jour. N. Y. Ent. Soc., 51:254.

South Dakota.

Liriomyza huidobrensis (Blanchard)

Agromyza huidobrensis Blanchard, 1926, Rev. Soc. Ent. Argent., 1:10.

Liriomyza huidobrensis (Blanchard): Blanchard, 1938, An. Soc. Cient. Argent., 126:356; Porter, 1939, Rev. Chile Hist. Nat., 43:139.

The larvae mine the leaves of cultivated *Cineraria* sp. Porter records the larvae's mining broad beans. Argentina, Chile.

Liriomyza imperfecta (Malloch), new combination

Agromyza imperfecta Malloch, 1934, Dipt. Patag. S. Chile., 6:475; Ortiz, 1946, Cat. Dipt. Chile, p. 141.

Chile.

Liriomyza interfrontalis (Melander), new combination

Agromyza interfrontalis Melander, 1913, Jour. N. Y. Ent. Soc., 21:263.

Washington.

Liriomyza langei Frick

Agromyza orbona Melander, 1913 (*nec* Meigen, 1830), Jour. N. Y. Ent. Soc., 21:258; Frost, 1943, Jour. N. Y. Ent. Soc., 51:254; Lange and Smith, 1947, Jour. Econ. Ent., 40:496.

Liriomyza langei Frick, 1951, Pan-Pac. Ent., 27:81.

Very closely related to *Liriomyza orbona* (Meigen) and to *L. flaveola* (Fallén). This economic species attacks *Pisum sativum, Beta vulgaris, Spinacia oleracea, Apium graveolens* var. *dulce,* and cultivated *Aster* sp. Washington, California.

Liriomyza lima (Melander), new combination

Agromyza lima Melander, 1913, Jour. N. Y. Ent. Soc., 21:265.

Idaho.

Liriomyza marginalis (Malloch), new combination

Agromyza marginalis Malloch, 1913, Ann. Ent. Soc. Amer., 6:283; Frost, 1924, Cornell Mem., 78:46.

The larvae mine in *Paspalum dilatatum* Poir. Illinois, South Carolina, Texas.

Liriomyza melampyga (Loew), new combination

Agromyza melampyga Loew, 1869, Berl. ent. Zeitschr., 13:48; Aldrich, 1905, Smithson. Misc. Coll., 46:648; Melander, 1913, Jour. N. Y. Ent. Soc., 21:258; Malloch, 1913, Ann. Ent. Soc. Amer., 6:282; Frost, 1924, Cornell Mem., 78:47.

Agromyza sorosis Williston, 1896, Trans. Ent. Soc. London, 1896:429.

Agromyza flaviventris Johnson, 1902 (*nec* Strobl, 1898), Canad. Ent., 34:242. Primary homonym.

The larvae mine the leaves and roots (?) of *Plantago* sp., and the leaves of *Philadelphus grandiflorus.* West Indies, eastern United States west to Colorado.

Liriomyza ornata (Meigen)

Agromyza ornata Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:176.

Liriomyza ornata (Meigen): Hendel, 1920, Arch. Naturgesch., Abt. A., 84:139; Hendel, 1936, *in* Lindner: Die Flieg. palaearkt. Reg., 59:567.

Agromyza signata Meigen, 1838, Syst. Beschr. bekann. eur. zweifl. Insekt., 7:398; Porter, 1936, Rev. Chile Hist. Nat., 40:426; Porter, 1938, Rev. Chile Hist. Nat., 42:172.

Porter reports that the larvae of *A. signata* mine the leaves of tomato and potato. Chile.

Liriomyza pacifica (Melander), new combination

Agromyza pacifica Melander, 1913, Jour. N. Y. Ent. Soc., 21:264; Malloch, 1918, Canad. Ent., 50:76.

Agromyza longispinosa Malloch, 1913, Ann. Ent. Soc. Amer., 6:276.

Washington, Illinois, British Columbia, Alaska.

Liriomyza pagana (Malloch), new combination

Agromyza pagana Malloch, 1934, Dipt. Patag. S. Chile, 6:475.

Argentina.

Liriomyza patagonica (Malloch), new combination

Agromyza patagonica Malloch, 1934, Dipt. Patag. S. Chile, 6:472.

Argentina.

Liriomyza phaseolunata (Frost), new combination

Agromyza phaseolunata Frost, 1943, Jour. N. Y. Ent. Soc., 51:256.

The larvae mine the leaves of lima beans. New Jersey.

Liriomyza politella (Malloch), new combination

Agromyza politella Malloch, 1934, Dipt. Patag. S. Chile, 6:473.

Similar to *L. virgo* (Zetterstedt). Argentina.

Liriomyza pusilla (Meigen)

Agromyza pusilla Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:185; Malloch, 1913, Ann. Ent. Soc. Amer., 6:278; Frost, 1924, Cornell Mem., 78:51; Frost, 1943, Jour. N. Y. Ent. Soc., 51:258.

Liriomyza pusilla (Meigen): Hendel, 1920, Arch. Naturgesch., Abt. A., 84:143; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:245.

Agromyza hieracii Kaltenbach, 1862, Verh. naturh. Ver. preuss. Rheinl. und Westphal., 19:36.

L. pusilla sens. str. is a leaf miner on *Hieracium* sp. and *Sonchus* sp. (Hendel, 1931*d*). The earlier European entomologists restricted it to the species mining *Euphorbia* sp. A pair reared from *Hieracium* sp., which I received from Dr. Hering, are distinct from any species now known

to me. Although *L. pusilla* has been recorded from many host plants in North America, the only specimens that could be *L. pusilla* s.s. are those reared from *Sonchus* sp. by Frost (1924).

Liriomyza quadrata (Malloch), new combination

Agromyza quadrata Malloch, 1934, Dipt. Patag. S. Chile, 6:471; Ortiz, 1946, Cat. Dipt. Chile, p. 141.

Chile.

Liriomyza quadrisetosa (Malloch), new combination

Agromyza quadrisetosa Malloch, 1913, Ann. Ent. Soc. Amer., 6:332.

Texas.

Liriomyza sativae Blanchard

Liriomyza sativae Blanchard, 1938, An. Soc. Cient. Argent., 126:354.

The larvae mine the leaves of alfalfa. Argentina.

Liriomyza schmidti (Aldrich), new combination

Agromyza schmidti Aldrich, 1929, Proc. Ent. Soc. Wash., 31:89.

The larvae mine the leaves of *Cliricidia maculata*. Costa Rica.

Liriomyza simulator (Malloch), new combination

Agromyza simulator Malloch, 1934, Dipt. Patag. S. Chile, 6:474; Ortiz, 1946, Cat. Dipt. Chile, p. 141.

Argentina, Chile.

Liriomyza subpusilla (Frost)

Agromyza subpusilla Frost, 1943 (*nec* Malloch, 1914), Jour. N. Y. Ent. Soc., 51:255; Lange, 1949, Pan-Pac. Ent., 25:91. Primary homonym.

A study of six paratypes from the personal collection of C. W. Sabrosky reveals that a number of species are involved in the concept of this species. The species is therefore not here renamed, although *L. subpusilla* is a primary homonym. The type is from Kansas.

Liriomyza trifolii (Burgess), new combination

Oscinis trifolii Burgess, 1880, Ann. Rept. U. S. Dept. Agric., 1879:201.

Agromyza trifolii (Burgess): Coquillett, 1898, Bull. Dept. Agric., Ent., 10:78; Malloch, 1913, Ann. Ent. Soc. Amer., 6:278; de Meijere, 1925, Tijdschr. Ent., 68:282; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:213.

Coquillett placed this species as a synonym of *Agromyza (Phytomyza) diminuta* (Walker), 1857, whereas Malloch placed both species under *L. pusilla* (Meigen). De Meijere thought that *A. trifolii* might be the same as *L. leguminosarum*, n. sp. However, the latter species Hendel synonymized with *L. congesta* (Becker), 1903. I have distinct specimens of *Liriomyza* sp. reared from various legumes, and *L. trifolii* may possibly be a valid species.

Liriomyza tubifer Melander

Liriomyza tubifer Melander, 1913, Jour. N. Y. Ent. Soc., 21:266.

Originally described in *Liriomyza* because of the large basal segment of the ovipositor. Haiti.

Liriomyza variata (Malloch), new combination

Agromyza variata Malloch, 1913, Ann. Ent. Soc. Amer., 6:277.

Maine.

Liriomyza virgo (Zetterstedt)

Agromyza virgo Zetterstedt, 1848, Dipt. Scand., 7:2775; Frost, 1943, Jour. N. Y. Ent. Soc., 51:254.

Liriomyza virgo (Zetterstedt): Hendel, 1920, Arch Naturgesch., Abt. A., 84:142; Hendel, 1932, *in* Lindner: Die Flieg. palaearkt. Reg., 59:260.

The larvae mine the stems of *Equisetum* sp. in Europe. Frost records this species from Michigan and Kansas.

Liriomyza xanthophora (Schiner), new combination

Agromyza xanthophora Schiner, 1868, Reise Freg. Novara, Zool., Dipt., 2:291; Malloch, 1913, Ann. Ent. Soc. Amer., 6:275.

Agromyza picta Coquillett, 1902, Jour. N. Y. Ent. Soc., 10:188.

The species was redescribed by Malloch, who placed *A. picta* in synonymy. Originally described from South America, also recorded from Mexico and New Mexico.

9. Genus *Metopomyza* Enderlein

[Gr., *metopum*, brow, forehead; plus *myza*]

Metopomyza Enderlein, 1936, Tierw. Mitteleur., 6 (3):180; Enderlein, 1936, Mitt. dtsch. ent. Ges., 7:42.

Haplomyza Hendel, 1920 (*nec* Hendel, 1914), Arch. Naturgesch., Abt. A., 84:144; Hering, 1927, Tierw. Deutschl., 6:77; Hendel, 1927, Zool. Anz., 69:250; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:198; Enderlein, 1936, Tierw. Mitteleur., 6 (3):179; Hendel, 1936, *in* Lindner: Die Flieg. palaearkt. Reg., 59:569; Frey, 1941, Enum. Insect. Fenn., 6:19; Melander, 1949, Ent. News, 60:57. New synonymy.

Type.—Agromyza flavonotata Haliday, 1833, by subsequent designation of Enderlein, 1936*b*.

Type of homonym and synonym.—Haplomyza: Phytomyza xanthaspis Loew, 1858, by original designation, 1920.

Adult.—Of moderate size, 1.5 to 2 mm. in body length. Shining black; scutellum broadly yellow centrally; genae and frontal vitta sometimes yellowish brown; halteres yellowish; wings hyaline or tinged with gray.

Head: Genae moderately developed; mesofacial plate short, broad; frontal vitta sunken below prominent genovertical plates and only the width of a single plate; genovertical plates very large, conspicuous, each equal to one-third the width between eyes. Antennal bases approximate; third segment rounded at apex or slightly concave dorsally; arista tapering uniformly, of moderate length. Proboscis short. Setae: vi well developed; 1 to 3, usually 2, ifo; 2 sfo; os usually relatively long, dorsally directed.

Setal pattern of thorax: 1 h; 1 prs; 1 sa; 0 or 1 ia, when present the ia is weakly developed and scarcely longer than the acr; 1 or 2 pa; 3 + 0 or 3 + 1 dc; 0 prsc; 4 to 6 rows of acr, extending posteriorly to first pair of dc; 1 pp; 2 npl; 1 aes; 1 kes.

Wing (fig. 24): Costa reaching M_{1+2}; m-m usually present (absent in *M. xanthaspis* Loew); M_{3+4} strong, ending in costa distad of wing center; Cu + Pl usually short, extending less than half the distance to wing margin.

Male terminalia: Aedeagal apodeme not extending posteriorly to anterior edge of ninth tergite; epiphallus large, terminating bluntly posteriorly; aedeagal hood large, relatively broad. Phallophore large, extending far beyond the anterior edge of the ninth tergite; portion bearing phallus small. Phallus relatively slender, long; basal section moderately short, of large diameter, longitudinal sclerites lightly sclerotized; median section slender, tubular, ventral processes slender, long; distal section composed of a pair of diverging tubules, which terminate separately. Ninth sternite gently vertically curved, anterior end somewhat curved dorsally, more so posteriorly; sidepieces thickened, broadly curved anteriorly, bearing relatively long ventral processes. Pregonites broadly united to ninth sternite, curving posteriorly, approximate centrally; without sensory pores or setae. Postgonites with outer process extending to phallophore; inner process separate, broad, extending about three-fourths of the distance to phallophore; ventral portion not broadened, bluntly and smoothly rounded. Ninth tergite widest centrally, as viewed laterally, strongly narrowing ventrally; bearing a number of heavy, blunt spines on posteroventral angles as well as a row of about 12 spines on the inward- and upward- turned inner surface, at about one-fourth of the distance between the ventral and dorsal margins of the tergite; articulated to ninth sternite dorsal to the mid-line between the ventral and dorsal margins. Surstyli borne on the anterior margin, about halfway between the ventral margin and the articulation with the ninth sternite; completely separated by a suture; rounded; directed anteriorly; each bearing a number of heavy spines and long setae; rather narrowly united to bacilliform sclerites. Bacilliform sclerites inconspicuous. Cerci moderately large, slender. Ejaculatory apodeme with base small, not curved to enclose part of bulb; stem short, broad; blade with outer angles sharp, not rounded, moderately expanded.

Larva.—(Compiled from de Meijere, 1937, 1941, 1944.) Larva of *M. flavonotata* (Haliday) only kind known. Yellow.

Head: Left mandible with 3, right with 2, teeth. Paraclypeal phragma almost straight, gradually narrowing posteriorly. Dorsad of antennae a crossband of small, rounded, colorless processes.

Body: Anterior spiracles rounded, each with about 9 bulbs. Abdominal cuticular processes rather large, broadly triangular, somewhat smaller anteriorly in the bands. Posterior spiracles with conical stems, each consisting of an arc of about 16 bulbs arranged in 2 irregular rows. Posterior end truncate, without tubercles, ventrally bearing 2 short lobes.

Hendel (1920) modified the concept of the genus *Haplomyza* from that expressed by Melander (1913). In 1927 Hendel found that his 1920 concept was polyphyletic and placed *Haplomyza* as a subgenus of *Liriomyza* and the species *H. atronitens* Hendel in *Cerodontha*. Hendel (1931*d*) later recognized the group but gave it subgeneric rank under the genus *Liriomyza*. Enderlein (1936*a*) raised *Haplomyza* to full generic standing and proposed *Metopomyza* for *flavonotata* Haliday and four other species, which he did not name, on the basis of the presence of cross vein m-m.

The name *Haplomyza* Hendel, 1914, must be reserved for the species included in *Antineura* of Melander, 1913. The next available name for the European species is *Metopomyza* Enderlein. The material examined included a pair of males of *M. xanthaspis* and a male and female of *M. flavonotata,* all lent by Dr. Hering. The male terminalia of the latter species were dissected.

This small genus contains only seven Palearctic species. To date none has been described from North America.

10. Genus *Xeniomyza* (Hering MS) de Meijere

[Gr., *xenius,* hospitable; plus *myza*]

Xeniomyza de Meijere, 1934, Tijdschr. Ent., 77:288; Hendel, 1936, *in* Lindner: Die Flieg. palaearkt. Reg., 59:515; Melander, 1949, Ent. News, 60:57.

Type.—*Xeniomyza ilicitensis* de Meijere, 1934, monobasic.

Adult.—Very small, not more than 1 mm. in body length. All setae relatively slender. Cinereous black, somewhat opaque, subshining, with yellow markings; head and pleurae mostly yellow; scutellum broadly yellow centrally; halteres yellow; wings slightly milky.

Head: Subtriangular in profile. Eye moderately small. Genae ventrally produced, sunken centrally; lunule ending dorsally in a prominent semicircular ridge exceeding height of genovertical plates; posterior half of frontal vitta sunken in dried specimens, rising about halfway to lunule to equal the rather prominent genovertical plates, thence extending outward to join lunule; longer than broad. Proboscis short. Antennal bases approximate; third segment moderately large, round at apex; arista very thickened on basal fifth, slender distally. Setae: vi moderately long, slender, greatly exceeding small setae of subcranial margin; 3 ifo, directed inward; 2 sfo, directed outward; os virtually absent, being very minute and sparse; pvt absent.

Setal pattern of thorax: 1 h; 1 prs; 1 sa; 0 ia; 1 pa; 3 + 1 dc (anterior 2 pair very small); 0 prsc; 2 or 3 rows of acr, sparse, on anterior half of mesonotum; 1 small pp; 2 npl; 1 aes; 1 kes.

Wing (fig. 25): Costa reaching slightly distad of M_{1+2}, well before wing tip; r-m nearer wing base than apex of R_1; m-m absent; M_{3+4} diverging strongly from slightly forward-directed M_{1+2}; cell Cu absent; Cu + Pl no more than a short, faint indication of a fold.

Male terminalia: Aedeagal apodeme extending posteriorly within ninth tergite; epiphallus relatively long, very broad, not curved, terminating bluntly; aedeagal hood very broad, extending slightly ventrad of epiphallus before doubling back, not anteriorly produced. Phallophore only slightly produced along aedeagal apodeme; portion bearing phallus short. Phallus short, moderately sclerotized; basal section nearly tubular, sclerites broad, ventral processes slender, short; median section very short, tubular; distal section a membranous, broadened, shortened complex. Ninth sternite very slightly curved vertically, posterior arms turned somewhat dorsally; sidepieces slender, bearing a strong ventral projection on each side; broadly curved anteriorly, not widened. Pregonites broadly united to ninth sternite; extending nearly to mid-line. Postgonites with outer dorsal process minute; inner strong; extending broadly ventrad of ninth tergite, not

heavily sclerotized, rounded ventrally. Ninth tergite articulated to ninth sternite about midway between dorsal and ventral margins; moderately and broadly produced posteroventrally; broader than high, to provide space for the broad aedeagal hood. Surstyli not differentiated from ninth tergite, not separated by a suture; bearing 2 or 3 strong blunt inward-directed spines. Bacilliform sclerites inconspicuous, narrowly united behind large aedeagal hood. Cerci moderately long, broad, thickened. Ejaculatory apodeme relatively large; base small; stem very short; blade expanding gradually.

Larva.—**(Compiled from de Meijere, 1934.) Of usual form, about 1.5 mm. in length. Calcospherites present.**

Head: Mandibles small, thickset, of equal length; 2 teeth of each equally curved posteriorly. Labial sclerite very short, greatly broadened. Paraclypeal phragma with dorsal process very broad, strongly curved centrally; ventral process equally broad, somewhat shorter.

Body: Anterior spiracles relatively small, base short; each with 6 or 7 bulbs. Abdominal cuticular processes relatively large, scattered, V- or D-shaped; anteriormost in the bands smaller; bands extending around body, well developed dorsally. Posterior spiracles relatively small, base short; each with 7 or 8 bulbs. Posterior end truncate; without tubercles.

Hering was given credit for *Xeniomyza* by de Meijere (1934) when the latter described the larva, and by Hendel (1936) when the adult was first described. Superficially, *Xeniomyza* and *Haplomyza* Hendel, 1914, are quite similar, and Hendel (1936) synonymized *Antineura* with *Xeniomyza*. A study of the male terminalia of the type of each genus has confirmed the fact that these two genera are distinct.

Two pairs of paratypes of *X. ilicitensis* were given to me by Dr. Hering. The larvae mine in the leaves of *Suaeda fruticosa* Forsk. in Spain. Two Austrian species, *Phytomyza balcanica* Strobl, 1900, and *Phytomyza tiefii* Strobl, 1901, were placed in *Xeniomyza* by Hendel (1936) on the basis of the descriptions. No specimen of either is known to exist. The genus is not represented in North America.

11. Genus *Haplomyza* Hendel

[Gr., *haploos*, single, simple; plus *myza*]

Haplomyza **Hendel, 1914 (n.n. for *Antineura* Melander, 1913, *nec* Osten Sacken, 1881), Ent. Mitt., 3:73; Watt, 1924, Trans. N. Z. Inst., 55:683; Malloch, 1934, Proc. Linn. Soc. N.S.W., 59:1; Melander, 1949, Ent. News, 60:57.**

Antineura **Melander, 1913 (*nec* Osten Sacken, 1881, Platystomatidae, Diptera), Jour. N. Y. Ent. Soc., 21:249; Hendel, 1936, *in* Lindner: Die Flieg. palaearkt. Reg., 59:515.**

Type.—Antineura togata **Melander, 1913, *ipso facto.***

Type of homonym.—Antineura: Antineura togata **Melander, 1913, by original designation.**

Adult: **Moderately small, 1 to 1.5 mm. in body length. Black, subshining or opaque, variably marked with yellow; scutellum yellow, at least centrally; halteres whitish; wings hyaline.**

Head: Genae moderately elongated ventrally, noticeably depressed centrally; lunule dorsally terminating in a constricted curve, slightly exceeding genovertical plates; frontal vitta in living specimens slightly convexly curved, slightly raised above genovertical plates, in dried specimens sunken between prominent genovertical plates, rising near middle to join lunule; genovertical plates slightly raised above eyes, as viewed in profile. Antennal bases approximate; third segment relatively large, rounded at apex, slightly longer than broad; arista thickened noticeably on basal fifth, slender distally, tapering. Proboscis short. Setae: vi moderately strong, greatly exceeding short setae of subcranial margin; 3 ifo, directed inward, third pair directed somewhat dorsally also; 1 sfo, directed outward and dorsally; os very sparse, extremely short, erect, but some dorsally directed.

Setal pattern of thorax: 1 h; 1 prs; 1 sa; 0 ia, but sometimes 2 or 3 small setulae anterior to the sa in ia row; 2 pa, inner minute; 3 + 1 dc, anterior 2 pair about half the length of first pair, usually a small seta between each dc and a row of 4 or 5 anterior to fourth dc; 0 prsc; acr sparse, in 2 or 3 rows, virtually absent posterior to third dc; 1 pp; 2 npl; 1 aes; 1 kes.

Wing (fig. 26): R_{2+3}, R_{4+5}, and M_{1+2} undulating, first and third more than second; C reaching M_{1+2}, slightly before or at wing tip; M_{3+4} strongly divergent from M_{1+2}, moderately weak, ending at middle of posterior margin of wing; m-m absent; Cu + Pl short, weak, becoming a fold which disappears well before wing margin; cell Cu complete.

Male terminalia: Aedeagal apodeme posteriorly extending to anterior margin of ninth tergite; epiphallus relatively long, not curved, terminating bluntly; aedeagal hood very long and very broad, extending distad of epiphallus to ventral margin of ninth tergite before doubling anteriorly to extend distad of anterior margin of ninth tergite. Phallophore greatly extended anteriorly along aedeagal apodeme; portion bearing phallus small, tubular. Phallus mostly membranous; basal section short, greatly broadened sclerites forming a nearly complete tube, ventral processes inconspicuous; median section short, membranous; distal section moderately elongate, slender, membranous. Ninth sternite with little vertical curvature, anterior end slightly curved dorsally, posteriorly hardly turned dorsally; sidepieces thickened, narrowly curved anteriorly. Pregonites broadly united to ninth sternite, extending slightly ventrad of and then somewhat dorsad of ninth sternite, approximate centrally; bearing a single strong seta posteriorly. Postgonites with outer process usually very minute, sometimes extending to phallophore; inner extending strongly dorsoanteriorly to meet phallophore; ventrally produced to ventral margin of ninth tergite, curving somewhat inward; terminating in a pair of strong teeth. Ninth tergite broader than high to provide space for the broad aedeagal hood, vertically rather flattened; articulated to ninth sternite somewhat dorsad of the mid-line between dorsal and ventral margins; with a heavy, sharp spine at posteroventral angles. Surstyli completely separated from ninth tergite by a suture; slightly elongate, extending ventrad of ninth tergite, terminating in 1 to 3 heavy, blunt, inward-curving spines; rather narrowly joined to bacilliform sclerites. Bacilliform sclerites only narrowly united posterior to large aedeagal hood. Cerci small; not flattened or broadened. Ejaculatory apodeme long, slender; base narrow, short; stem slender, long; blade very slightly expanding, sublinear.

Female terminalia: Seventh abdominal segment relatively large, conical, black. A single extremely large, flattened, circular accessory gland present.

Larva.—Moderately small, about 2 mm. in length, robust. Shining white.

Head: Mandibles each with a very strong terminal tooth and a small second one; the right mandible greatly elongate so that its terminal tooth is well removed; second tooth of right mandible opposite or very slightly beyond terminal tooth of smaller left mandible. Labial sclerite moderately short, sometimes relatively thickened. Paraclypeal phragma nearly straight or broadly, smoothly curved; usually very slender, rarely thickened. Ventral process elongate, three-fourths or more the length of the dorsal process.

Body: Anterior spiracles small, not expanded distally; each with 6 to 8 bulbs. Abdominal cuticular processes in relatively narrow bands, irregularly spaced; small, subtriangular, subequal in size. Posterior spiracles small, stem short, scarcely expanded distally; each with 6 to 8 bulbs in a nearly closed circle, opening toward mid-line of body. Posterior end with a small pair of mucronate lobes dorsad of and anterior to posterior spiracles on eighth segment; a second pair, usually flattened but sharp-tipped, ventrad of posterior spiracles; and a blunt lateral pair about midway between dorsal and ventral margins; anal lobes moderately large, acuminate.

Partly because of the modified concept of *Haplomyza* by Hendel (1920) (now *Metopomyza* Enderlein), *Antineura* Melander has received little notice from students of the family. In 1936, Hendel synonymized the genus with *Xeniomyza,* an understandable move in view of the superficial similarity of the adults. Melander (1949) removed *Haplomyza,* and subsequent terminalia studies have confirmed that both genera are quite distinct.

Watt (1924) described *Haplomyza chenopodii* from New Zealand, atypical in having only 3 fronto-orbital setae, and Malloch (1934*b*) described *Haplomyza imitans* from Australia, which is also atypical in having only 1 ifo and 2 sfo setae. A study of the specimens is necessary to determine whether these two species belong in *Haplomyza* s.s.

In addition to the three species listed below, I have reared two species that are new, which will be described in a separate paper. This brings the North American species in *Haplomyza* to five.

NEW WORLD SPECIES IN THE GENUS HAPLOMYZA

Haplomyza togata (Melander)

Antineura togata Melander, 1913, Jour. N. Y. Ent. Soc., 21:250.

Haplomyza togata (Melander): Hendel, 1914, Ent. Mitt., 3:73.

A long series, compared with Melander's type, were reared from leaves of *Amaranthus retroflexus* L. and *A. hybridus* L. The larvae first make a serpentine and then a large blotch mine, the latter usually obscuring the linear portion. California, Washington.

Haplomyza chlamydata (Melander)

Antineura chlamydata Melander, 1913, Jour. N. Y. Ent. Soc., 21:250.

Haplomyza chlamydata (Melander): Hendel, 1914, Ent. Mitt., 3:73.

Washington.

Haplomyza palliata (Coquillett)

Phytomyza palliata Coquillett, 1902, Jour. N. Y. Ent. Soc., 10:191.

Antineura palliata (Coquillett): Melander, 1913, Jour. N. Y. Ent. Soc., 21:250.

Haplomyza palliata (Coquillett): Hendel, 1914, Ent. Mitt., 3:73.

The larvae mine in *Portulaca* sp. New Mexico.

12. Genus *Phytoliriomyza* Hendel

[Gr., *phyton*, plant; plus *liriomyza*]

Phytoliriomyza Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:17, 203; Hering, 1932, Zeitschr. PflKrankheit., 42:575; de Meijere, 1937, Tijdschr. Ent., 80:210; Frey, 1941, Enum. Insect. Fenn., 6:19; Hering, 1944, Mitt. dtsch. ent. Ges., 12:58.

Type.—Agromyza perpusilla Meigen, 1830, monobasic.

Adult.—Rather elongate, of moderate size, 1.5 to 2 mm. in body length. Opaque grayish black; pleurae and head marked with yellow; scutellum concolorous with mesonotum, dark; halteres pale yellow, bearing a grayish-black spot at apex concolorous with mesonotum; wings grayish hyaline.

Head: Genae large, distinctly sunken; frontal vitta slightly broader than long, slightly depressed below the moderately wide genovertical plates; lunule not prominent dorsally. Third antennal segment large, rounded at apex, longer than broad. Proboscis short. Setae: vi moderately small, not more than twice as long as setae of subcranial margin; 1 ifo, directed slightly inward; 2 sfo, directed dorsally; os rather numerous, directed anteriorly.

Setal pattern of thorax: 1 h; 1 prs; 1 sa; 0 ia, but a few small setulae in ia row; 2 pa; 3 + 1 dc; 0 prsc; 2 sparse rows of acr ending between third pair of dc; 1 pp; 2 npl, posterior subequal to anterior in length; 1 aes; 1 kes.

Wing (fig. 27): Costa reaching M_{1+2}, at wing tip; m-m present, more than its own length beyond r-m; r-m nearer wing base than apex of R_1; Cu + Pl weakly developed; cell Cu complete. Axillary lobe and calypter well developed.

Male terminalia: Aedeagal apodeme relatively long, extending anteriorly to posterior margin of third segment, not extending posteriorly to reach anterior margin of ninth tergite; epiphallus moderately short; aedeagal hood extremely long, extending far ventrad of epiphallus before doubling back to form a broad hood extending somewhat anteriorly. Phallophore elongated anteriorly along aedeagal apodeme; portion bearing phallus very small. Phallus of variable length; basal section moderately long, tubular, bearing a pair of ventral, posteriorly curving processes; median section tubular, of moderate length, not bearing visible processes; distal section composed of a pair of slender dark rods, elongate or shortened, surrounded by membrane. Ninth sternite somewhat vertically curved, anterior tip dorsally curved, at posterior end greatly dorsally curved; sidepieces slender, rounded anteriorly, bearing posterior to center on either or both sides an elongate ventral process. Pregonites broadly united to ninth sternite; composed of flattened

plates extending somewhat dorsally along posterior arms of ninth sternite; each bearing a few sensory pores. Postgonites with outer process extending anterodorsally to anteriorly produced phallophore; united with ventral process at pregonites, from which arises the short inner process; ventral process enlarged distally into a broad, incurved, rounded, flat plate. Ninth tergite broadened ventrally, as viewed in profile; articulated to ninth sternite dorsad of center; ventral margin curved inward and dorsally, with a pair of heavy sharp spines on posterolateral angles. Surstyli on anterior margin, separated by a suture; rounded or elongate, projecting anteroventrally; bearing 3 or 4, or 6 or 7, moderately long heavy spines anteriorly, with usually a pair posterior to these; inner projections rather broadly extending dorsally within ninth tergite to attach to bacilliform sclerites. Bacilliform sclerites extending posteriorly and ventrally to unite narrowly before cerci. Cerci short or long, slender, not flattened. Ejaculatory apodeme large; base either expanded perpendicularly to plane of blade or narrow, elongate along slightly produced bulb toward phallophore; stem short, broad; blade greatly or moderately expanded, outer angles rather sharp.

Larva.—De Meijere (1937) described a larva which he believed to be of the species *P. perpusilla* (Meigen). The following description is taken from his work.

Slender, anterior half somewhat wider.

Head: Mandibles each with 2 teeth, alternating; posteroventrally elongate, slenderly acuminate. Paraclypeal phragma with dorsal process small, almost straight; ventral process slender, nearly straight, half as long as dorsal.

Body: Anterior spiracles small, each nearly divided into 2 lobes; each with a row of about 7 bulbs. Abdominal cuticular processes small, scattered, short triangular; bands narrow, completely absent on seventh and eighth abdominal segments. Posterior spiracles each with 3 bulbs, relatively short, not hooklike or elongate. Posterior end truncate, without tubercles; anal lobes small.

Hendel separated this unique group as a subgenus of *Liriomyza* on the basis of the anterior direction of the orbital setulae. The terminalia have been found to be widely divergent from those found in species of *Liriomyza,* and the raising of *Phytoliriomyza* to full generic standing (Frey, 1941) is substantiated.

New World Species in the Genus Phytoliriomyza

Phytoliriomyza perpusilla (Meigen)

Agromyza perpusilla Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:181; Melander, 1913, Jour. N. Y. Ent. Soc., 21:255.

Liriomyza perpusilla (Meigen): Hendel, 1920, Arch. Naturgesch., Abt. A., 84:139; Hendel, 1931, *in* Lindner: Die Flieg. palaearkt. Reg., 59:203.

Phytoliriomyza perpusilla (Meigen): Frey, 1941, Enum. Insect. Fenn., 6:19.

Agromyza tarsella Zetterstedt, 1848, Dipt. Scand., 7:2763.

Agromyza dorsata Siebke, 1864, Nytt Mag. f. Naturv., 10:169.

Agromyza immaculata (Coquillett), 1902, Jour. N. Y. Ent. Soc., 10:185 (as *Odinia*); Malloch, 1913, Ann. Ent. Soc. Amer., 6:289.

Agromyza oasis Becker, 1907, Zeitschr. f. Hym. und Dipt., 7:406.

The foregoing synonymy is taken from Hendel (1931*d*), although Melander (1913) first synonymized *A. immaculata.* Two males of *A. immaculata* were lent by C. W. Sabrosky from his personal collection. Terminalia studies confirm that this species is a synonym of *P. perpusilla.* It is widespread in Europe and North America.

The larvae of *Phytoliriomyza perpusilla* are known to be stem miners of plants in the family Compositae, and Hering (1944) reported *P. halterata* adults reared from mined leaves of *Soldanella alpina* L. (Primulaceae) in Austria. He pointed out that *P. halterata* is a valid species in spite of the synonymy given by Hendel (1920, 1931) and that there must be other hosts, since *S. alpina* is not found in Spain or in the Canary Islands.

Phytoliriomyza halterata may be distinguished from *P. perpusilla* by the distinctive terminalia, particularly the short distal section of the phallus; by the strongly oblique position of cross vein m-m; by the very short ultimate section of M_{3+4}, which is darkened for slightly more than a third of its length, becoming a fold distally; and by the over-all slightly darker coloration.

13. Genus **Xyraeomyia**, n. gen.

[Gr., *xyraeus*, shorn; plus *myia*, in reference to the reduction of setae]

Type.—Xyraeomyia conjunctimontis, n. sp.

Adult.—Moderately small, not elongate, rather slender, 1.25 to 1.5 mm. in body length. Setae on head and body reduced in number and often in length. Grayish brown, opaque; head and pleurae extensively yellow; mesonotum and scutellum dark, concolorous; halteres with knob concolorous with mesonotum; wings hyaline.

Head: Genae not elongate, deeply depressed centrally; mesofacial plate relatively short; lunule moderately large, not conspicuous; frontal vitta broader than long; genovertical plates not prominent. Antennae with bases approximate; third segment rounded, broader than long; arista slightly enlarged on basal fifth, tapering uniformly distally. Proboscis relatively large, not elongate. Setae: vi relatively small, about twice size of small setae of subcranial margin; 1 ifo, directed inward; 2 sfo, directed dorsally and outward; os sparse, directed anteriorly.

Setal pattern of thorax: 1 h, very small, less than half the length of the prs; 1 prs; 1 sa; 0 ia, and no small setulae in ia row; 2 pa, inner minute; 0 prsc; 3 + 1 dc, first 2 pair long, second 2 pair about half the length of first pair; a row of 3 or 4 small setulae anterior to fourth dc; 0 acr; 4 sc; 1 pp; 2 npl, the posterior not more than half the length of anterior; 1 aes; 1 kes.

Wing (fig. 28): Costa reaching M_{1+2} at wing tip; apex of R_1 and r-m equidistant from wing base; m-m absent; M_{3+4} moderately diverging from M_{1+2}, terminating in margin distad of wing center; cell Cu not completely closed, transverse portion of Cu very weak, but Pl broken immediately before uniting with Cu; Cu + Pl well developed for about half the distance to wing margin, a faint fold distally. Axillary lobe very small; calypter virtually absent, only a narrow strip present.

Male terminalia: Aedeagal apodeme relatively short, anteriorly extending to anterior margin of fifth or somewhat into fourth abdominal segment, posteriorly to within ninth tergite; epiphallus large, long, nearly colorless, scarcely distinguishable from aedeagal hood; aedeagal hood extremely large, broad, extending somewhat distad of epiphallus and posteroventrad of ninth tergite, doubling back anteriorly to slightly distad of anterior margin of ninth tergite. Phallophore elongate anteriorly, reaching slightly distad of anterior margin of ninth tergite; portion bearing phallus short, darkly sclerotized. Phallus moderately long, slender; basal section very short, tubular, ventral processes united and forming a posteriorly directed, flattened, moderately broad blade covered with minute setulae; median section tubular, long, slender, nearly straight, scarcely sclerotized; distal section somewhat dorsally curved, long, terminating in a pair of short tubules. Ninth sternite short, very strongly curved vertically; anterior end turned ventrally; centrally bearing on each side a ventrally directed sclerite of moderate length; strongly curved dorsally posterior to this point, attaching to ninth tergite dorsad of center; arms to bacilliform sclerites short; sidepieces not thickened; hypandrial apodeme absent. Pregonites broad, flattened plates, approximate centrally, where slightly turned dorsally; bearing numerous minute setulae on inner margin and 2 or 3 centrally. Postgonites with outer process extending dorsally to phallophore, elongate, sigmaform; inner dorsal arm very short; ventral portion moderately short, not extending ventrad of ninth tergite, strongly incurved to meet ventrally on mid-line, anteriorly widened near center, acuminate distally. Ninth tergite nearly square in outline; not elongate ventrally; articulated to ninth sternite somewhat dorsad of center; ventrally not turned inward; bearing many fine setulae and scattered setae, most numerous on posteroventral angles. Surstyli not separated by a suture, conical, somewhat dorsoventrally flattened, terminating bluntly, directed inward, meeting on mid-line; distally bearing numerous small setulae. Bacilliform sclerites moderately broad; attached to surstyli by an unsclerotized membrane; only united at cercal attachment. Cerci

dorsally situated; very large, broad, not flattened. Ejaculatory apodeme moderately small; base small, slightly attenuated toward duct; stem short, broad; blade short, moderately expanded, outer angles rounded. Bulb relatively large, nearly circular, flattened; duct attached lateroventrad.

Female terminalia: Seventh abdominal segment very short, strongly conical, light brown.

Larva.—Unknown.

Xyraeomyia conjunctimontis, n. sp.

Male.—Yellow with following structures darkened: head with ocellar triangle and back of head grayish brown; frontal vitta, basal half of second and all of third antennal segments slightly darkened; arista dark brown; eyes reddish brown. Mesonotum broadly grayish brown, extending laterally slightly beyond prs, sa, and outer pa setae; scutellum concolorous; humeri darkened on dorsal half; notopleural triangle slightly darkened centrally; anepisternum with a small faint dark area ventrally; katepisternum with a large, brownish triangular area; episternum dark; postnotum extensively darkened. Halteres with knobs concolorous with mesonotum. Legs with a small brownish area dorsally on fore coxae; femora slightly darkened; tibiae and tarsi grayish brown. Abdomen with first 5 tergites grayish brown dorsally, sixth only on anterior half; pleural areas and sternites yellowish; ninth tergite yellow.

Head in profile with eye large; mesofacial plate receding, genae moderately small, at vibrissa only one-eighth eye height, one-fourth at posterior angle; 3 relatively long setae on subcranial margin, half as long as vibrissae; setae along posterior margin sparse, slender. Frontal vitta three-fourths as long as broad, sunken below genovertical plates; lunule broad, smoothly rounded, in height two-thirds the length of frontal vitta; genovertical plates not prominent, hardly raised above eyes, narrow; each bearing 1 ifo subequal in length to upper sfo; lower sfo slightly more than two-thirds the length of upper sfo; 5 os, about one-fifth the length of upper sfo, slender. Vertical triangle scarcely larger than ocellar triangle; ocellar setae well developed, extending anteriorly nearly two-thirds the length of frontal vitta. Pvt, vti, vte setae strong. Antennae with third segment of moderate size, subspherical, in diameter about one-third the eye height, heavily setulose anteriorly; arista long, nearly four times as long as diameter of third segment, setulose. Proboscis moderately large, not elongate; palpi relatively large, broad, flattened. Subcranial cavity relatively broad.

Thorax with mesonotum subquadrate, nearly bare; a setula anterior to prs; 1 sa; 0 ia, 0 setulae in ia row; 2 pa, inner slightly less than half as long as outer; 0 prsc; 2 to 4 setulae anterior to fourth dc; first and second dc large, long, widely spaced; third dc in line with transverse suture, very close to second, four times as close to second as the second is to first; fourth very slightly farther from third than third from second; second dc three-fourths as long as first; third dc one-third as long as second, and three-fourths as long as fourth. Scutellar setae long. Pleurae: humeri with 2 setulae plus 1 short h; 1 pp, small; 2 npl, posteriormost half as long as anterior seta, slender; anepisternum with 2 dorsally directed setulae on dorsal margin, 1 aes plus 2 setulae on posterior margin; katepisternum with 1 setula on dorsal margin plus 1 kes.

Legs with few setulae, reduced somewhat in numbers, relatively short; mid-tibial apical spur short.

Wing (fig. 28) about two and one-third times as long as broad; costa reaching M_{1+2}, approximately at wing tip; costal segments in proportions of 5.5 : 2 : 1; cross vein r-m very short, situated basad of termination of R_1 in costa; ultimate segment of R_{4+5} nearly eight times as long as penultimate; cross vein m-m absent; M_{3+4} relatively strong, reaching wing margin distad of middle of wing.

Abdomen ovoid, dorsally sparsely covered with slender setulae.

Body, 1.25 mm. in length; wing, 1.25 mm. in length.

Male terminalia: (Described from two dissected specimens preserved in glycerine.) Aedeagal apodeme relatively short, anteriorly extending to anterior margin of fifth segment; epiphallus long, about one-fifth length of aedeagal apodeme; aedeagal hood extremely large, about one-third length of aedeagal apodeme, very broad. Phallophore very elongate anteriorly, reaching one-third length of aedeagal apodeme. Phallus slender, long, equal to ninth sternite in length; basal section very short, about one-sixth length of phallus, 2 sclerites slender, not united, ventral processes long, exceeding length of section by one-third, united, flattened, setulose; median section tubular, about one-third length of phallus, very lightly sclerotized, no processes; distal section long, nearly half

the length of phallus, somewhat curved dorsally, terminating in a pair of very short, diverging tubules. Ninth sternite half the length of aedeagal apodeme, sidepieces slender; anterior one-third turned somewhat ventrally; strongly curved dorsally posterior to pregonites for a distance equal to half the length of the ninth sternite; posterior arms short. Pregonites broad flattened plates, approximate centrally, where turned dorsally; bearing numerous minute setulae on inner margin and 2 or 3 centrally. Postgonites with outer process elongate sigmaform, sharply curved ventrally; inner arm very short; ventral portion short, about one-third height of ninth tergite, not exceeding ventral margin of ninth tergite; strongly incurved, acuminate. Ninth tergite about as high as long; articulated to ninth sternite dorsad of center; ventrally not turned inward; bearing numerous fine setulae and scattered setae, about 6 on each posteroventral angle. Surstyli not separated by a suture; directed inward; conical but somewhat dorsoventrally flattened, rounded distally; bearing fewer than 12 fine setulae. Bacilliform sclerites long, one-fourth length of aedeagal apodeme; moderately broad; united only at cercal attachment. Cerci dorsally situated; large, one-third height of ninth tergite; not flattened, about half as wide as long; bearing numerous fine setulae, 4 or 5 elongate setae ventrally. Ejaculatory apodeme about one-fourth length of aedeagal apodeme; base small; stem short, broadened; blade flaring distally, outer angles rounded; as broad as length of stem and blade. Ejaculatory bulb large, nearly circular, brownish.

Female.—Similar to male in color and general features. Palpi darkened; genovertical plates with 6 and 7 os; 4 and 6 setulae anterior to fourth dc; 0 setulae on dorsal margin of anepisternum; fourth, fifth, and sixth abdominal sternites grayish brown, posterior margins narrowly yellow; seventh abdominal segment conical, short, one-eighth length of abdomen, light brown, shining.

Holotype.—Male, Pyramid Camp, El Dorado County, California, August 18, 1948, K. E. Frick; deposited in California Academy of Sciences collection.

Paratypes.—3 males, 6 females, topotypical; 2 males, 5 females, August 18, 1948, Camp Sacramento, El Dorado County, California, K. E. Frick; 1 female, June 29, 1948, Mount Hermon, Santa Cruz County, California, K. E. Frick. All by sweeping. Paratypes have been deposited in the U. S. National Museum, the Zoologisches Museum, Berlin, and in my collection.

Other material examined.—3 females from Pyramid Camp and 1 male and 2 females from Camp Sacramento, all preserved in alcohol because of their inferior condition.

This species was found only in hills and mountains. Two locations—Pyramid Camp (elevation about 5,600 feet), near Kyburz on U. S. Highway 50, and Camp Sacramento (elevation 6,500 feet), not far from Phillips, also on Highway 50—are in the Sierra Nevada. Mount Hermon, not far from Santa Cruz on the ocean, is in the Coast Range at an elevation of slightly over 800 feet.

No host plants could be found for *X. conjunctimontis*. At Pyramid Camp the dominant plant in the area swept was *Lotus oblongifolius* (Benth.). At Camp Sacramento a partly shaded valley covered with grasses and annuals was swept. Only a single specimen of *X. conjunctimontis* was taken at Mount Hermon, but there were numerous *Phytoliriomyza perpusilla* (Meigen) and some *Phytobia clara* (Melander), where the dominant plants were chamise (*Adenostoma fasciculatum* H. and A.), manzanita (*Arctostaphylos glandulosa* Eastw.), the lupines *Lupinus latifolius* Agardh. and *Lupinus variicolor* Steud., bush monkey flower (*Diplacus aurantiacus* Jepson), and bracken (*Pteris aquilina* L.).

14. Genus *Phytagromyza* Hendel

[Gr., *phyton*, plant; plus *agromyza*]

Phytagromyza Hendel, 1920, Arch. Naturgesch., Abt. A., 84:145; de Meijere, 1926, Tijdschr. Ent., 69:227; Hering, 1927, Tierw. Deutschl., 6:78; Hendel, 1927, Zool. Anz., 69:269; Hendel, 1932, *in* Lindner: Die Flieg. palaearkt. Reg., 59:275; Enderlein, 1936, Tierw. Mitteleur., 6 (3):180; Hendel, 1936, *in* Lindner: Die Flieg. palaearkt. Reg., 59:518, 569; de Meijere, 1941, Tijdschr. Ent., 84:19; Kloet and Hincks, 1945, Check List Brit. Insects, p. 402.

Aulagromyza Enderlein, 1936, Tierw. Mitteleur., 6 (3):180.
Paraphytomyza Enderlein, 1936, Tierw. Mitteleur., 6 (3):180; Enderlein, 1936, Mitt. dtsch. ent. Ges., 7:42.

Type.—Domomyza flavocingulata Strobl, 1909, by original designation.

Types of synonyms.—Aulagromyza: Phytagromyza hamata Hendel, 1932, monobasic; *Paraphytomyza: Phytomyza xylostei* Robineau-Desvoidy, 1851, by subsequent designation of Enderlein, 1936*b*.

Adult.—Of moderate size, not robust or elongate, 1.5 to 2.5 mm. in body length. Grayish black to black, variably marked with yellow, sometimes extensively so; halteres yellow; wings hyaline.

Head: Genae usually moderately small, in some species rather elongated ventrally; frontal vitta approximately square or wider than long; lunule moderately high, laterally constricted, or broad; genovertical plates relatively broad, somewhat prominent, sometimes raised above frontal vitta. Antennal bases approximate; third segment rounded, rarely terminating in a sharp angle distally; arista tapering uniformly. Proboscis short, except in *P. hamata,* in which the mediproboscis and labella are elongate. Setae: vi usually differentiated from setae of subcranial margin, but often subequal to them; 2, usually, to 4 ifo; 1, rarely, or 2 sfo; os dorsally directed, not numerous, or absent.

Setal pattern of thorax: 1 h; 1 prs; 1 sa; 1 ia; 1, rarely, or 2 pa; usually 3 + 1 dc, rarely 2 + 0 or 3 + 0 dc; 0, or usually 1, prsc; acr numerous or moderate in numbers; 1 pp; 2 npl; 1 aes; 1 kes.

Wing (fig. 29): Costa reaching R_{4+5}; m-m present or absent; when present, may be directly below r-m, never basad to it, usually distad, but never so far from it but that the last section of M_{3+4} is less than twice the length of the penultimate section.

Male terminalia: Aedeagal apodeme extending posteriorly to within ninth tergite; epiphallus short, straight; aedeagal hood short, broad. Phallophore usually short, sometimes extending anteriorly over aedeagal apodeme a distance equal to length of the ninth sternite; portion bearing phallus very short. Phallus ventrally curved to pass through shortened ninth sternite; basal section composed of 2 broad, short sclerites, ventral processes short or elongate, inconspicuous; median section short, composed of 2 sclerites; distal section originating near center of median section, rising at an acute angle or perpendicularly to it; the whole phallus surrounded by a large membranous area. Ninth sternite usually shortened, anterior end broadly rounded; sidepieces sometimes moderately broadened, sometimes thickened anteriorly, moderately to greatly so posteriorly; posterior arms short. Pregonites broadly united to ninth sternite, flattened; usually extending posteriorly, rarely anteriorly; bearing a few sensory pores distally and usually 1 or 2 strong setae posteriorly. Postgonites with inner and outer processes separate, both attached dorsally to phallophore; ventrally slender; terminating bluntly in 1 or 2 teeth. Ninth tergite articulated to ninth sternite dorsally; ventrally slightly receding from articulation; not elongate ventrally; rarely produced dorsally into a long pointed process. Surstyli usually not separated by a suture, rarely a fine suture present; moderately and broadly produced inward, only slightly so ventrally; bearing long, slender setae which are directed inward; usually broadly united to bacilliform sclerites. Bacilliform sclerites moderately broadened; united only near cerci. Cerci short, slender, thickened, sometimes very small. Ejaculatory apodeme small or of moderate size; base small, moderately elongate; stem short; blade moderately to broadly expanded, rarely absent. Bulb elongate; ejaculatory duct originating laterally.

Larva.—Of moderate size, about 2.5 mm. in length, sometimes very robust. White or yellowish.

Head: Mandibles each with 2 teeth, usually alternating. Paraclypeal phragma with dorsal process slender, somewhat curved; ventral arm seldom sclerotized, but if so, very slender, relatively long, from one-half to three-fourths the length of the dorsal arm, and then the posterior spiracles usually complex, each with many bulbs; ventral process short. No processes or tubercles on head or prothorax.

Body: Anterior spiracles each with 11 to 17 bulbs, usually in 2 large equal lobes; some lobes very short. Abdominal cuticular processes in wide or narrow bands; subtriangular, small; usually larger centrally in the bands. Posterior spiracles nearly circular or in 2 equally elongate lobes; usually each with many bulbs, up to 30, some bulbs being larger, forming a complex pattern; rarely with 3 bulbs each; sometimes a conical process centrally. Some species in the Ethiopian region have both posterior spiracles on a common base (de Meijere, 1941).

The adults of this genus are superficially similar to those found in *Napomyza* and *Phytomyza.* Few larvae were known until 1941, when de Meijere had sufficient material to characterize more fully the larvae and to establish their distinctness. Species from such diverse genera as *Agromyza, Domomyza* (synonym of *Agromyza*), *Napomyza,* and *Phytomyza* have been removed to *Phytagromyza* by Hendel.

Aulagromyza Enderlein was erected for *P. hamata* Hendel on the basis of the absence of cross vein m-m and the great elongation of the proboscis. *Paraphytomyza* Enderlein contained five species, having in common the absence of cross vein m-m and the proboscis of normal length. Hendel (1936) pointed out that, excluding *P. xylostei* (Robineau-Desvoidy), 1851, the larvae of which mine the leaves of *Symphoricarpos* and *Lonicera,* the other four species could be considered as a subgenus. These four—*P. populicola* (Haliday), 1833, *P. tridentata* (Loew), 1858, *P. populi* (Kaltenbach), 1864, and *P. populivora* (Hendel), 1926—all mine in leaves of *Populus nigra* L. in Europe.

Phytagromyza is not a large genus, there being only 21 Palearctic species listed in 1932. Hendel added four more in 1936; only one has been described since that time. Only three species can be definitely placed in the genus from North America.

New World Species in the Genus Phytagromyza

Phytagromyza aristata (Malloch), new combination

Agromyza aristata Malloch, 1915, Canad. Ent., 47:13.

The presence of a pair of prsc setae place the species in *Phytagromyza.* Illinois.

Phytagromyza orbitalis (Melander), new combination

Phytomyza orbitalis Melander, 1913, Jour. N. Y. Ent. Soc., 21:271; Frost, 1924, Cornell Mem., 78:82.

I have reared the species from blotch mines in the leaves of *Symphoricarpos albus* (L.), *S. mollis* Nutt., and *S. rotundifolius* Gray in California. Melander's specimens are from Washington and Idaho. Western United States.

Phytagromyza plagiata (Melander), new combination

Napomyza plagiata Melander, 1913, Jour. N. Y. Ent. Soc., 21:273.

Agromyza plagiata (Melander): Malloch, 1918, Canad. Ent., 50:130.

Agromyza brevicostalis Malloch, 1913, Ann. Ent. Soc. Amer., 6:283.

The presence of the prsc setae and the venation of the wing (Malloch, 1913*a:* fig. 8) place the species in *Phytagromyza.* Idaho, Montana.

15. Genus *Gymnophytomyza* Hendel

[Gr., *gymnos,* lightly clad, naked; plus *phytomyza*]

Gymnophytomyza Hendel, 1936, *in* Lindner: Die Flieg. palaearkt. Reg., 59:517; de Meijere, 1941, Tijdschr. Ent., 84:28; de Meijere, 1944, Tijdschr. Ent., 86:76.

Type.—Phytomyza heteroneura Hendel, 1920, monobasic.

Adult.—Small, about 1.5 mm. in body length. All setae relatively slender and somewhat shortened. Dark brown, shining; head and legs mostly yellow; halteres pale yellowish; wings hyaline.

Head: Subtriangular as viewed in profile. Eye moderately small. Genae very elongate ventrally, sunken centrally; membranous mouth cavity elongate, extending dorsally half the distance to antennal bases; mesofacial plate not elongate; frontal vitta slightly longer than broad, rising anteriorly to meet projecting lunule; genovertical plates narrow, prominent, raised above eyes, particularly anteriorly. Antennal bases approximate, moderately sunken; third segment short, but somewhat elongate ventrally; arista borne on anterodorsal angle, of moderate length, tapering uniformly. Proboscis short; palpi broadened distally. Setae: vi about twice size of setulae of subcranial margin; 3 or 4 strongly inward-directed ifo; 1 outward-directed sfo; os numerous, inconspicuous, very short, erect.

Setal pattern of thorax: 1 h; 1 prs; 1 sa; 0 ia; 1 pa; 3 + 1 or 4 + 1 slender dc, those anterior to first about half its size, not differentiated from acr; 0 prsc; acr sparse, in 3 or 4 rows, long, slender; 0 pp; 2 npl; 1 aes; 1 kes.

Wing (fig. 30): Costa strong to slightly distad of R_{4+5}, very slender to slightly distad of M_{1+2}; veins of R_s very strong; M_{1+2} weakest longitudinal vein, terminating posterior to wing tip; M_{3+4} fading near wing margin; m-m absent; cell Cu closed; Cu + Pl straight, strong to near wing margin; anal lobe absent; calypter virtually so.

Male terminalia: Not dissected. Phallus with basal and median sections obscured, shortened; distal section slender, moderately elongate, mebranous, terminating in a pair of very short diverging processes. Ninth sternite moderately long, sidepieces slender, broadly curved anteriorly. Postgonites moderately long, each terminating in a single large tooth, apparently not broadened. Ninth tergite elongate, somewhat narrowing ventrally, bluntly rounded ventrally; articulation to ninth sternite dorsally situated about two-thirds of distance from ventral to dorsal margins; narrowing ventrally, as viewed from the posterior. Surstyli not separated by a suture, turned inward along anterior margin for one-third of distance to dorsal margin; bearing only setae. Cerci inconspicuous, longer than broad.

Larva.—(Compiled from de Meijere, 1941, 1944.) Of moderate size, 2.5 mm. in body length. Grayish white.

Head: Mandibles each of equal size, each with small teeth; posterior smaller; not alternating. Labial sclerite short, broad. Paraclypeal phragma with dorsal process relatively broad, narrowing posteriorly, ventral arm minute; ventral process equal to upper in length, expanded distally.

Body: Prothoracic processes absent. Anterior spiracles each in a broad curve of about 14 bulbs. Abdominal cuticular processes on all segments, whole body surface covered with the processes; small, round, low; brownish to nearly colorless. Posterior spiracles each in a regular curve of 11 to 15 bulbs. Posterior end conical, acuminate and bearing 4 small papillae.

Gymnophytomyza heteroneura, a unique European species, originally not fully characterized by Hendel (1920), remained in the genus *Phytomyza* until 1936, at which time a full description was given. Subsequently, de Meijere (1941) described the larva and the biology. The larvae mine in the developing seeds of *Galium aparine.* The species is not common. Two males, on loan from Dr. Hering, were studied, but the male terminalia were not dissected. The genus is not represented in North America.

16. Genus *Pseudonapomyza* Hendel

[Gr., *pseudes,* false; plus *nape,* glade; plus *myza*]

Pseudonapomyza Hendel, 1920, Arch. Naturgesch., Abt. A., 84:115; de Meijere, 1926, Tijdschr. Ent., 69:235; Hering, 1927, Tierw. Deutschl., 6:89; Hendel, 1932, *in* Lindner: Die Flieg. palaearkt. Reg., 59:302; Malloch, 1935, Insect. Samoa, 6:341; de Meijere, 1940, Tijdschr. Ent., 83:178; de Meijere, 1944, Tijdschr. Ent., 86:69.

Type.—*Phytomyza atra* Meigen, 1830, monobasic.

Adult.—Of moderate size, 2 mm. in body length. Shining black; halteres whitish yellow; wings milky.

Head: Genae elongate ventrally; junction of lunule and frontal vitta exceeding genovertical plates in height; upper half of frontal vitta sunken slightly below prominent, shining genovertical plates, rising anteriorly to join lunule; about twice as long as broad; genovertical plates about one-third the width of frontal vitta; vertical triangle relatively large, shining; ocellar triangle normal. Antennal bases approximate; third segment concave dorsally, forming an acute angle at tip; arista thickened on basal fifth, slender distally. Proboscis short. Setae: 3 or 4 ifo, directed inward; 1 sfo, directed dorsally and outward; os erect.

Setal pattern of thorax: 1 h; 1 prs; 1 sa; 1 ia, weakly developed; 1 or 2 pa, inner small when present; 3 + 0 dc; 0 prsc; 5 or 6 rows of sparse acr, extending posteriorly to first dc; 1 pp; 2 npl; 1 aes; 1 kes.

Wing (fig. 31): Costa reaching R_{4+5}; veins of R_s very strong, M_{1+2} scarcely more than a fold, ending at apex of wing; M_{4+5} little stronger; m-m present, basad of r-m, appearing to be the basal

section of M_{3+4}, leaving cell 1-M_2 (discal) open basally and united with cell M (second basal); cell Cu closed; Cu + Pl weak.

Male terminalia: Aedeagal apodeme extending posteriorly within ninth tergite; epiphallus rather small, blunt; aedeagal hood extending distad of anterior margin of ninth tergite, rather broad. Phallophore extending distad of anterior margin of ninth tergite; portion bearing phallus very short. Phallus moderately elongate, heavily sclerotized outwardly; basal section relatively long, at least one sclerite fully sclerotized for its entire length, other only partly so, ventral processes moderately elongate, slender, sclerotized; median section a pair of rather slender sclerites, very short; distal section heavily sclerotized, broad, usually long, somewhat tubular. Ninth sternite moderately elongate; sidepieces slender, smoothly rounded anteriorly, thickened posteriorly where strongly projecting dorsally; arms attaching to bacilliform sclerites, short. Pregonites rather small, flattened plates, extending posteriorly; bearing 2 to 4 sensory pores and a single anteriorly directed seta. Postgonites with outer process rather slender, curved, attached dorsally to phallophore and to pregonite; inner process extending dorsally about half the distance from pregonite to phallophore; ventrally extending nearly to ventral margin of ninth tergite, terminating in 2 blunt teeth. Ninth tergite broadly elongate ventrally, at distal end somewhat widening anteriorly; articulation with ninth sternite dorsally situated. Surstyli not separated by a suture, broadly united to bacilliform sclerites; bearing rather sparse setae on inner and lower surfaces. Bacilliform sclerites not united before attachment to cerci. Cerci very small; short, widening somewhat centrally, not flattened. Ejaculatory apodeme large; base partly sclerotized, not broadened perpendicularly to plane of blade; stem broadened in plane of blade, short; blade moderately expanded, smoothly rounded. Ejaculatory bulb relatively small; duct attached laterally.

Larva.—Of moderate size, 2 to 3 mm. in length. White.

Head: Mandibles each with 2 teeth, moderately removed from each other; alternating, appearing as 4 equally spaced teeth in lateral view. Labial sclerite small, straight. Paraclypeal phragma with dorsal arm of dorsal process almost straight to posterior end, then slightly ventrally curved, ventral arm a short spur; ventral process short. Sense papillae large, hemispherical.

Body: Anterior spiracles not lobed, expanded anteriorly; each with 6 to 8 bulbs, none elongate. Abdominal cuticular processes relatively small, triangular; dispersed, those posteriorly situated in the bands somewhat larger and in more definite rows. Between these bands a row of elongate spines on each segment that continue around the segment, those on anal segment the longest. Posterior spiracles each with 3 or 6 bulbs, none elongate.

Pseudonapomyza was erected for a single species with peculiar wing venation. That cross vein m-m is present and the basal section of M_{3+4} absent tends to be obscured in some specimens. The wing from which the figure was taken clearly shows a short portion of M_{3+4} basad of cross vein m-cu. Other adult characters are more readily discernible.

This is a very small genus with only a single Palearctic species, *P. atra* (Meigen), 1830, a pair of which were received from Dr. Hering. *P. spicata* (Malloch), 1914, the larvae of which mine the leaves of sugar cane and corn in Formosa, Samoa, and Fiji, is distinct (Malloch, 1935*b*) in that the third pair of dc setae is very close to the second pair and is about half as long as the first pair. The terminalia of the two species show distinct differences. Two species are known from North America.

New World Species in the Genus *Pseudonapomyza*

Pseudonapomyza atra (Meigen)

Phytomyza atra Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:191.

Pseudonapomyza atra (Meigen): Hendel, 1920, Arch. Naturgesch., Abt. A., 84:115; Hendel, 1932, *in* Lindner: Die Flieg. palaearkt. Reg., 59:302.

Phytomyza morio Zetterstedt, 1848, Dipt. Scand., 7:2818.

Phytomyza acuticornis Loew, 1858, Wien. ent. Monatschr., 2:78; Melander, 1913, Jour. N. Y. Ent. Soc., 21:269; Frost, 1924, Cornell Mem., 78:62.

Phytomyza nitidula Malloch, 1913, Proc. U. S. Nat. Mus., 46:151; Frost, 1924, Cornell Mem., 78:62.

The larvae mine the leaves of grasses. Widespread in Europe and the United States.

Pseudonapomyza lacteipennis (Malloch)

Phytomyza lacteipennis Malloch, 1913, Proc. U. S. Nat. Mus., 46:152; Frost, 1924, Cornell Mem., 78:62; Malloch, 1935, Insect. Samoa, 6:342.

Pseudonapomyza lacteipennis (Malloch): Hendel, 1932, *in* Lindner: Die Flieg. palaearkt. Reg., 59:302.

P. lacteipennis was synonymized with *P. acuticornis* by Frost. Hendel (1932) and Malloch (1935*b*) have shown *P. lacteipennis* to be distinct because of the coloration of the arista, which is yellowish white basally, and of the tarsi, which are brownish yellow. New Mexico.

17. Genus *Napomyza* (Haliday MS) Westwood

[Gr. *nape,* glade; plus *myza*]

Napomyza (Haliday MS) Westwood, 1840, Introd. Classif. Insects, Gen. Syn., 2:151; Schiner, 1864, Fauna Austr., Flieg., 2:513; Aldrich, 1905, Smithson. Misc. Coll., 46:646; Coquillett, 1910, Proc. U. S. Nat. Mus., 37:574; Melander, 1913, Jour. N. Y. Ent. Soc., 21:272; Malloch, 1913, Proc. U. S. Nat. Mus., 46:129; Hendel, 1920, Arch. Naturgesch., Abt. A., 84:148; de Meijere, 1926, Tijdschr. Ent., 69:229; Hering, 1927, Tierw. Deutschl., 6:82; Hendel, 1927, Zool. Anz., 69:269; Hendel, 1932, *in* Lindner: Die Flieg. palaearkt. Reg., 59:305 (as subgenus); Enderlein, 1936, Tierw. Mitteleur., 6 (3):180.

Dinevra Lioy, 1864, Atti Ist. Veneto, (3) 9:1315; Coquillett, 1910, Proc. U. S. Nat. Mus., 37:533.

Type.—Phytomyza elegans Meigen, 1830, monobasic (as *Phytomyza festiva* Meigen, 1830).

Type of synonym.—Dinevra: Phytomyza elegans Meigen, 1830, by subsequent designation of Coquillett, 1910*b*.

Adult.—Moderately large, relatively slender, 2 to 4.5 mm. in body length. Mostly black or cinereous, opaque, variably marked with yellow; halteres whitish or yellow; wings hyaline.

Head: Usually anteriorly projecting dorsad of antennae, as viewed laterally. Genae elongate ventrally, sometimes nearly equaling eye height. Frontal vitta wider than long, sometimes slightly sunken below prominent genovertical plates immediately anterior to ocellar triangle, rising before middle; frontal lunule often rather prominent; ptilinal fissure inconspicuous. Antennal bases nearly approximate; third segment usually rounded anteriorly, sometimes rectangular or forming a rounded obtuse angle at apex. Proboscis short. Setae: 1 to 4, usually 2, ifo, directed inward; 1, or usually 2 sfo, directed dorsally; os directed anteriorly.

Setal pattern of thorax: 1 h; 1 prs; 1 sa; 0 ia; 2 pa; 3 + 1 dc; 0 prsc; 2 to 6 or 7 rows of acr, varying from sparse to numerous; 1 pp; 2 npl; 1 aes; 1 kes.

Wing (fig. 32): Costa reaching R_{4+5}, before wing tip; m-m present, usually slightly distad of r-m but not more so than its own length, sometimes basad of r-m; r-m never farther from wing base than the termination of R_1 in C; M_{1+2} weakest longitudinal vein, ending at wing tip or immediately posterior to it; cell Cu closed; Cu + Pl distinct, at least a fold approaching wing margin.

Male terminalia: Aedeagal apodeme extending posteriorly within ninth tergite; epiphallus moderately long, slightly curved, acuminate; aedeagal hood moderately large, somewhat anteriorly produced. Phallophore narrowly extending anteriorly along aedeagal apodeme; portion bearing phallus tubular, rather elongate. Phallus long, relatively slender; basal section long, 2 sclerites slender, ventral processes long; median section composed of 2 slender sclerites, moderately long, ventral processes elongate, conspicuous; distal section long, curved ventrally, sigmaform, composed of a pair of slender tubes terminating distally in a bulbous knob. Ninth sternite dorsally curved at posterior end; sidepieces thickened and broadened; hypandrial apodeme short, broad, rounded distally. Pregonites broadly united to ninth sternite; centrally with a few sensory pores and posteriorly bearing one or a few fine setae. Postgonites very large, conspicuous; outer process well developed, extending anterodorsally to phallophore; inner process separate, reaching about halfway to phallophore; extremely broad ventrally, terminating broadly and irregularly, bearing 1 or more strong teeth anteriorly; sometimes bearing an anteriorly directed seta. Ninth tergite dorsally

articulated to ninth sternite; strongly and broadly elongated ventrally, sometimes postero-ventrally. Surstyli not separated by a suture; covered inwardly and dorsally with numerous long setae; dorsally rather broadly united to bacilliform sclerites. Bacilliform sclerites composed of conspicuous sclerotized rods extending from very short posterior arms of ninth sternite to cerci; united at cerci. Cerci rather small; short, thickened. Ejaculatory apodeme small, base circular, small; stem very short, wide; blade very short, outer angles sharp. Ejaculatory bulb spherical, duct attached ventrally.

Larva.—(Compiled from de Meijere, 1926.)

Head: Mandibles each usually with 2 teeth (rarely only 1), terminal tooth the larger; alternating. Paraclypeal phragma with dorsal arm of dorsal process slender, somewhat curved, ventral arm rarely present, minute if present; ventral process short.

Body: Prothoracic process dorsad of antennae usually present. Anterior spiracles either small, not expanded distally, each with about 9 bulbs, or 2-lobed with numerous bulbs. Abdominal cuticular processes usually small, subtriangular; those posterior in the bands sometimes larger. Posterior spiracles each with many bulbs, either 1- or 2-lobed; one sometimes more elongate. Posterior end without tubercles; anal lobes rarely distinct.

It is of interest that Westwood designated *Phytomyza lateralis* Fallén, 1823, as the type of *Phytomyza,* referring to Curtis (1832), fig. 393. In this figure cross vein m-m is present, although Westwood characterized *Phytomyza* as lacking it. *Dinevra* Lioy was erected for four species, all with cross vein m-m present. Coquillett (1910*b*), in designating the type, listed the first species of the series.

Hendel (1932) placed the species with cross vein m-m as a subgenus of *Phytomyza.* He felt that the presence or absence of that vein was not sufficient reason for maintaining generic rank. Terminalia studies have confirmed that the species placed here are quite distinct from *Phytomyza* species which are without this cross vein.

Malloch (1913*b*) recognized *Napomyza* for those species with cross vein m-m situated basad of or directly in line with cross vein r-m. A wing of *Napomyza lateralis* (Fallén) was included (Malloch, 1913*b:* plate 4, fig. 4) to show the position of these veins. Cross vein m-m may also be slightly distad of r-m, and *Agromyza davisii* and *A. parvicella* are included here. To illustrate the venation, a wing of *N. lateralis,* a Holarctic species, is used, rather than one of *N. elegans* (Meigen), a very similar European species.

Napomyza is a small genus, there being only eighteen species described from the Palearctic region. Only three species are here placed in the genus from North America, and none is known from South America.

The name *Napomyza anomala* Strobl was introduced by Melander (1913). *Phytomyza anomala* Strobl, 1893, is placed in *Phytagromyza* by Hendel (1932), and *Phytomyza anomala* Strobl, 1898, is a synonym of *N. glechomae* (Kaltenbach), 1862. Both species have cross vein m-m distad of r-m, whereas Melander's specimen has this cross vein basad of r-m; the name is therefore not included in the catalogue of species.

New World Species in the Genus *Napomyza*

Napomyza davisii (Walton), new combination

Agromyza davisii Walton, 1912, Ent. News, 23:463; Melander, 1913, Jour. N. Y. Ent. Soc., 21:253; Malloch, 1913, Ann. Ent. Soc. Amer., 6:284.

The wing (Malloch, 1913*a*: fig. 8) shows cross vein m-m distad of r-m. This cross vein is usually basad of or in line with r-m in *N. lateralis,* but it may be distad (Hendel, 1932). Malloch (1913*a*) notes that specimens in the United States National Museum were labeled *Napomyza lateralis,* and that *N. davisii* may be a synonym of *N. lateralis.* Indiana.

Napomyza lateralis (Fallén)

Phytomyza lateralis Fallén, 1823, Dipt. Suec., Phytomyzid., 2 (41):3.

Napomyza lateralis (Fallén): Schiner, 1864, Fauna Austr., Flieg., 2:314; Melander, 1913, Jour. N. Y. Ent. Soc., 21:273.

Phytomyza flaviceps Macquart, 1835, Hist. Nat. Insect., Dipt., 2:616.

Phytomyza euphrasiae Kaltenbach, 1860, Verh. naturh. Ver. preuss. Rheinl. und Westphal., 17:237.

The larvae mine in the pith of stems, in the receptacles, and sometimes in the leaves of many plants, usually in the family Compositae. Widespread in Europe, North Africa, Canary Islands, and North America including Alaska.

Napomyza parvicella (Coquillett)

Agromyza parvicella Coquillett, 1902, Jour. N. Y. Ent. Soc., 10:189; Malloch, 1913, Ann. Ent. Soc. Amer., 6:287; Malloch, 1918, Canad. Ent., 50:132.

Napomyza parvicella (Coquillett): Melander, 1913, Jour. N. Y. Ent. Soc., 21:273.

Melander removed the species from *Agromyza*, in which genus Malloch (1918*b*) replaced it. Alaska.

18. Genus *Phytomyza* Fallén

[Gr., *phyton*, plant; plus *myza*]

Phytomyza Fallén, 1810, Nov. Dipt. Dispon. Method., p. 21, no. 67, fig. 10; Fallén, 1823, Dipt. Suec., Phytomyzid., 2 (41):2; Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:188; Macquart, 1835, Hist. Nat. Insect., Dipt., 2:615; Westwood, 1840, Introd. Classif. Insects, Gen. Syn., 2:151; Zetterstedt, 1848, Dipt. Scand., 7:2810; Hardy, 1849, Ann. Mag. Nat. Hist., (2) 4:390; Walker, 1853, Insecta Brit., Dipt., 2:241; Rondani, 1856, Dipt. Ital. Prod., 1:135; Zetterstedt, 1860, Dipt. Scand., 14:6465; Lioy, 1864, Atti Ist. Veneto, (3) 9:1315; Schiner, 1864, Faun. Austr., Flieg., 2:312; Braschnikov, 1897, Ann. Inst. Agron. Moscow, 3:40; Aldrich, 1905, Smithson. Misc. Coll.,46:645; Becker *et al.*, 1905, Kat. palaearkt. Dipt.,4:252; Coquillett, 1910, Proc. U. S. Nat. Mus., 37:590; Melander, 1913, Jour. N. Y. Ent. Soc., 21:269; Hendel, 1920, Arch. Naturgesch., Abt. A., 84:151; Frost, 1924, Cornell Mem., 78:58; de Meijere, 1926, Tijdschr. Ent., 69:236; Hering, 1927, Tierw. Deutschl., 6:90; Hendel, 1932, *in* Lindner: Die Flieg. palaearkt. Reg., 59:304.

Chromatomyia Hardy, 1849, Ann. Mag. Nat. Hist., (2) 4:290; Braschnikov, 1897, Ann. Inst. Agron. Moscow, 3:40; Coquillett, 1910, Proc. U. S. Nat. Mus., 37:523; Collin, 1911, Ent. Mon. Mag., 22:255.

Type.—Phytomyza flaveola Fallén, 1810, monobasic.

Type of synonym.—Chromatomyia: Phytomyza obscurella Fallén, 1823, by subsequent designation of Coquillett, 1910*b*.

Adult.—Of moderate size, slightly elongate, 1.5 to nearly 4 mm. in body length. Black to cinereous, usually opaque, variably marked with yellow, rarely extensively yellow; halteres whitish or yellow.

Head: Form variable, as viewed laterally. Genae usually moderately elongated ventrally; frontal vitta sometimes slightly sunken below genovertical plates, usually much broader than long. Antennal bases slightly separated; third segment rounded at apex, sometimes approaching rectangular but never with a sharp angle; arista sometimes greatly thickened basally, tapering uniformly distally. Proboscis short. Setae: vi well developed; 1 or 2 ifo; 1 (rarely) or 2 sfo, upper sometimes very small; os directed anteriorly.

Setal pattern of thorax: 1 h; 1 prs; 1 sa; 0 ia; 2 pa; 3 + 1 dc; 0 prsc; 2 to about 6 rows of acr, sometimes sparse, rarely absent; 1 pp; 2 npl; 1 aes; 1 kes.

Wing (fig. 33): Costa reaching R_{4+5}, usually well in front of wing tip; m-m absent; r-m never farther from wing base than termination of R_1 in C; M_{1+2} weakest longitudinal vein, ending at wing tip or immediately posterior to it; cell Cu closed; Cu + Pl distinct, at least as a fold approaching wing margin.

Male terminalia: Aedeagal apodeme extending posteriorly within ninth tergite; epiphallus relatively short, curved, acuminate; aedeagal hood relatively small, extending slightly ventrad of epiphallus before broadly doubling back, not anteriorly produced. Phallophore moderately developed, extending anteriorly to near anterior margin of ninth tergite; portion bearing phallus

very short. Phallus relatively elongate, broadened, only slightly sclerotized, strongly turned ventrally to pass through small ninth sternite; basal section moderately long, sclerites slender, ventral processes moderately long, slender; median section apparently very short; distal section appearing to originate near base of median section, usually being composed of a dorsally projecting piece and an anterior one, resulting in the phallus' being greatly broadened and complex distally. Ninth sternite very short, broad; sidepieces broadened, moderately thickened anteriorly, greatly so posteriorly where dorsally curved; posterior arms attaching to bacilliform sclerites short. Pregonites broadly united to ninth sternite; extending strongly anteriorly, slightly ventrally, and sometimes also dorsally, approximate centrally; each bearing a pair of setae, which are directed inward or posteriorly. Postgonites strongly developed; outer and inner processes broadly united to phallophore, appearing as a single sclerite; ventrally produced, not greatly broadened, terminating in a blunt tooth. Ninth tergite not produced ventrally; articulation to ninth sternite somewhat dorsad of center. Surstyli borne centrally or even nearer posterior margin; usually separated from ninth tergite by an inconspicuous suture; only slightly elongate ventrally; bearing short, slender setae; united rather broadly to bacilliform sclerites. Bacilliform sclerites slender, united posteriorly near cerci. Cerci relatively short, thickened, slender. Ejaculatory apodeme small, base slightly elongate or nearly circular; stem very short, broad; blade very short, moderately broadened, outer angles rather sharp. Ejaculatory duct attached laterally to bulb.

Larva.—Of moderate size, 2 to 3 mm. in length; moderately robust. Usually white.

Head: Mandibles each with 2 teeth, terminal tooth larger; usually alternating. Paraclypeal phragma with dorsal arm of dorsal process slender, slightly curved, ventral arm rarely present, minute if present; ventral process usually slender, shorter than dorsal.

Body: A prothoracic process dorsad of antennae sometimes present. Anterior spiracles either small, slightly wider distally, each with 6 to 10 bulbs, or 1- or 2-lobed with numerous bulbs; lobes sometimes elongate. Abdominal cuticular processes numerous, small, scattered. Posterior spiracles either small, little wider than stem, each with 6 to 9 bulbs, or 2-lobed, or nearly circular, or irregular and complex and arched centrally; bulbs numerous in circular and complex forms, some bulbs often elongate in the latter type. Posterior end without tubercles; anal lobes usually inconspicuous or small.

Hendel (1936) considered *Phytomyza flaveola* Fallén, 1810, a *nomen nudem* because Fallén did not mention the species in a subsequent paper (1823*b*). Although the description is brief, Fallén included a figure of the wing (Fallén, 1810: fig. 10). On the basis of the figure and the light color suggested by the name, Hendel placed *P. flaveola* as probably a light form of *P. ranunculi* (Schrank). Hendel (1920, 1932) considered *P. affinis* Fallén, 1823, the type, a species which had first been designated by Rondani (1856). Coquillett (1910*b*) designated the third species listed by Hardy as the type of *Chromatomyia*. It is this species, *P. obscurella* Fallén, that is here used to illustrate the wing venation found in the genus *Phytomyza*.

Hardy restricted *Chromatomyia* to species that have a flattened puparium and that pupate within the mines. Among the seven species he included was *Napomyza lateralis* (cross vein m-m present). The larvae of all the species are rather distantly removed from that of the type on the basis of the form and size of the anterior and posterior spiracles and the number of bulbs.

Braschnikov (1897), in resurrecting *Chromatomyia*, noted that the flattened puparium and pupation in the mines made this genus biologically similar to *Ophiomyia*, n. gen., and that *Phytomyza* and *Agromyza* formed a biologically similar group. He further defined *Chromatomyia* as including the species without acrostichals and with wing venation such that a line perpendicular to M_{1+2} from the apex of R_{2+3} falls at the apex of M_{3+4}. Four species were included, with *P.*

atricornis Meigen and *P. affinis* Fallén as the only two included by Hardy. The four species placed in *Chromatomyia* by Braschnikov were similar in wing venation and in having very few acr setae; but *P. brischkei* Hendel, 1922 (n.n. for *P. atra* Brischke, 1880, *nec* Meigen, 1830), has an oval puparium and pupates in the ground.

Collin (1911) did not accept the genus *Chromatomyia*. He mentioned that it was based on pupal characters and appeared to include species in both *Napomyza* and *Phytomyza*.

Phytomyza was restricted by Hardy for species in which the larvae pupate in the ground and that have an ovoid puparium. Three species were listed. Braschnikov characterized *Phytomyza* as having acrostichals and having wing venation such that a line drawn from the apex of R_{2+3} perpendicular to M_{1+2} falls beyond the apex of M_{3+4}. These characters are the more common among the species in this large genus than are those listed above for *Chromatomyia*.

Phytomyza is a very large genus; attempts to divide it on the basis of natural groups have not been entirely successful. Hendel (1936) included 205 Palearctic species, and about 30 have been described since that time. About 41 species are known at present from the Nearctic region and only 5 from the Neotropical region.

Four species originally described in *Phytomyza* have been removed; one has been placed in *Phytagromyza* (*orbitalis* Melander) and three in *Pseudonapomyza* (*acuticornis* Loew, *nitidula* Malloch, *lacteipennis* Malloch).

A few species of *Phytomyza* have been reported from the Nearctic region that are now considered as absent from this region; these are: *Phytomyza bipunctata* Loew, 1858, *P. crassiseta* Zetterstedt, 1860, *P. dasyops* Hendel, 1920, and *P. nigritella* Zetterstedt, 1848. The first species was first mentioned by Melander (1913), who has specimens from Strobl. Hendel (1934) believed that Melander's specimens probably belong to *P. albiceps* Meigen. Melander (1913) placed *P. crassiseta* in the Nearctic region, but after a study of Melander's material, I found that they do not agree with Hendel's description. Frost (1924) notes that his specimens of *P. crassiseta* differed from that described by Hendel (1920). The name *P. dasyops* was first used for a specimen from Alaska (Frost, 1924). Hendel (1934) doubts that the two are the same and restricts the distribution of *P. dasyops* to Austria. Specimens of *P. nigritella* in Melander's collection identified by Strobl were compared with material reared by me and were found to be the same. Specimens subsequently sent to Dr. Hering were found by him to be close to *P. periclymeni* de Meijere, 1924.

New World Species in the Genus *Phytomyza*

Phytomyza affinalis Frost

Phytomyza affinalis Frost, 1924, Cornell Mem., 78:84.

Canada.

Phytomyza affinis Fallén

Phytomyza affinis Fallén, 1823, Dipt. Suec., Phytomyzid., 2 (41):3; Lundbeck, 1900, Vid. Medd., 5:306; Melander, 1913, Jour. N. Y. Ent. Soc., 21:271; Frost, 1924, Cornell Mem., 78:62; Hendel, 1934, *in* Lindner: Die Flieg. palaearkt. Reg., 59:334.

Phytomyza liturata Brullé, 1832, Exped. Sci. Morée, 3 (2):322.

Phytomyza nigricornis Macquart, 1835, Hist. Nat. Insect., Dipt., 2:618.

Phytomyza geniculata Schiner, 1864 (*nec* Macquart, 1835), Fauna Austr., Flieg., 2:313.

? Phytomyza solita Walker, 1857, Trans. Ent. Soc. London, 4:232.

Chromatomyia syngenesiae Hardy p.p., 1849, Ann. Mag. Nat. Hist., (2) 4:391.

Melander questionably included *P. solita* as a synonym. *Phytomyza affinis* has been confused with *P. atricornis* Meigen. The larvae mine the leaves of a number of plants, primarily those in the family Compositae. Europe, North Africa, North America.

Phytomyza albiceps Meigen

Phytomyza albiceps Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:194; Melander, 1913, Jour. N. Y. Ent. Soc., 21:271; Frost, 1924, Cornell Mem., 78:63; Hendel, 1934, *in* Lindner: Die Flieg. palaearkt. Reg., 59:337.

Phytomyza bipunctata Strobl, 1893 (*nec* Loew, 1858), Wien. ent. Zeitung, 12:136; Melander, 1913, Jour. N. Y. Ent. Soc., 21:271.

Hendel believes that Melander has the *B. bipunctata* of Strobl and not that of Loew, and that neither Melander nor Frost has *P. albiceps* s.s. He therefore did not include *P. albiceps* definitely in the North American fauna. Melander has specimens from various regions of the United States.

Phytomyza analis Zetterstedt

Phytomyza analis Zetterstedt, 1848, Dipt. Scand., 7:2842; Melander, 1913, Jour. N. Y. Ent. Soc., 21:270.

Phytomyza rufescens von Roser, 1840, Korresp.-Bl. wuertt. landw. Ver., 8:63.

Phytomyza terminalis Becker *et al.*, 1905 (*nec* Meigen, 1830), Kat. palaearkt. Dipt., 4:259.

Hendel doubtfully included the North American records for this species, believing that Melander has another species. Europe, North America.

Phytomyza angelicella Frost

Phytomyza angelicella Frost, 1927, Ann. Ent. Soc. Amer., 20:218.

Reared from *Angelica atropurpurea.* New York.

Phytomyza aquilegiana Frost

Phytomyza aquilegiae Coquillett, 1898 (*nec* Hardy, 1849), Bull. Dept. Agric., Ent., 10:78; Melander, 1913, Jour. N. Y. Ent. Soc., 21:271.

Phytomyza aquilegiana Frost, 1930, Ann. Ent. Soc. Amer., 23:459.

The larvae make large, greenish blotch mines in the leaves of *Aquilegia* sp. I have reared the species from various localities in California from *Thalictrum fendleri* Engelm., *Aquilegia truncata* F. & M., and *A. pauciflora* Jepson, the last at 9,600 feet elevation in the Sierra Nevada. Probably widespread in North America.

Phytomyza atricornis Meigen

Phytomyza atricornis Meigen, 1838, Syst. Beschr. bekann. eur zweifl. Insekt., 7:404; Frost, 1924, Cornell Mem., 78:68; Hendel, 1934, *in* Lindner: Die Flieg. palaearkt. Reg., 59:353; Melis, 1935, Redia, 21:205; Cohen, 1936, Ann. Appl. Biol., 23:612.

Phytomyza geniculata Macquart, 1835 (*nec* Brullé, 1832), Hist. Nat. Insect., Dipt., 2:619.

Phytomyza nigricornis Hardy, 1849 (*nec* Macquart, 1835), Ann. Mag. Nat. Hist., (2) 4:391.

Phytomyza horticola Goureau, 1851, Ann. Soc. Ent. France, (2) 9:148.

Phytomyza lateralis Goureau, 1851 (*nec* Fallén, 1823), Ann. Soc. Ent. France, (2) 9:156.

Phytomyza tropaeoli Dufour, 1857, Ann. Soc. Ent. France, (3) 5:39.

Phytomyza fediae Kaltenbach, 1860, Verh. naturh. Ver. preuss. Rheinl. und Westphal., 17:250.

Phytomyza linariae Kaltenbach, 1862, Verh. naturh. Ver. preuss. Rheinl. und Westphal., 19:83.

Phytomyza pisi Kaltenbach, 1864, Verh. naturh. Ver. preuss. Rheinl. und Westphal., 21:305.

Phytomyza lateralis Lintner, 1888 (*nec* Fallén, 1823), 41st Rept. N. Y. Mus., 1888:73.

Phytomyza chrysanthemi Kowarz, 1891, 44th Rept. N. Y. Mus., 1891:243; Melander, 1913, Jour. N. Y. Ent. Soc., 21:271; Smulyan, 1914, Mass. Agric. Expt. Sta. Bull., 157: 21; Frost, 1924, Cornell Mem., 78:70.

Phytomyza subaffinis Malloch, 1914, Ann. Mus. Hungar., 12:335.

Chromatomyia syngenesiae Hardy p.p., 1849, Ann. Mag. Nat. Hist., (2) 4:391.

Hendel synonymized all the above species with the exception of *P. lateralis* of Lintner, which was synonymized by Kowarz. *P. chrysanthemi* can no longer be considered a valid name because a study of the type by Hendel revealed that it is a synonym of *P. atricornis.* Hendel (1934) listed about 230 host plants in 30 plant families, making this species the most polyphagous species known in the family. I have reared it from serpentine mines in the leaves of *Mentha* sp., *Stachys californica* Benth., *Malva borealis* Wallm., *Melilotus indica* All., *Sonchus*

oleraceus L., *S. asper* L., *Matricaria* sp., *Chrysanthemum frutescens, Artemisia vulgaris* L., *Picris echioides* L., *Cenosia mikaniodiodes, Taraxacum kok-sghyz, Gnaphalium leucocephalum* Gray, cultivated *Zinnia* sp., and *Cineraria* sp. A very widespread species, having been reported from every continent and from many islands.

Phytomyza atripalpis Aldrich

Phytomyza atripalpis Aldrich, 1929, Proc. Ent. Soc. Wash., 31:89.

British Columbia.

Phytomyza auricornis Frost

Phytomyza auricornis Frost, 1927, Ann. Ent. Soc. Amer., 20:217.

Closely related to *P. flavicornis* Fallén. New York.

Phytomyza bicolor Coquillett

Phytomyza bicolor Coquillett, 1902, Jour. N. Y. Ent. Soc., 10:191; Frost, 1924, Cornell Mem., 78:69.

The species is not considered a synonym of *P. abdominalis* Zetterstedt by Frost. New York.

Phytomyza centralis Frost

Phytomyza centralis Frost, 1936, Ann. Ent. Soc. Amer., 29:318.

The larvae mine the leaves of *Clematis* sp. Costa Rica.

Phytomyza clematovora Coquillett

Phytomyza clematovora Coquillett, 1910, Proc. Ent. Soc. Wash., 12:131; Frost, 1924, Cornell Mem., 78:71.

The larvae mine the leaves of *Clematis* sp. Canada, Texas, Idaho, Indiana, Washington, D.C.

Phytomyza delphiniae Frost

Phytomyza delphiniae Frost, 1928, Canad. Ent., 60:77; Griswold, 1928, Jour. Econ. Ent., 21:855.

The larvae mine the leaves of *Delphinium cultorum*. Pennsylvania.

Phytomyza diminuta Walker

Phytomyza diminuta Walker, 1857, Trans. Ent. Soc. London, 4:233.

Agromyza diminuta (Walker): Coquillett, 1898, Bull. Dept. Agric., Ent., 10:78; Malloch, 1913, Ann. Ent. Soc. Amer., 6:278.

Agromyza dimidiata (Walker): Melander, 1913, Jour. N. Y. Ent. Soc., 21:267 (*lapsus calami*).

Coquillett believed that this species was a true *Agromyza* and synonymized species with it that now belong in the genus *Liriomyza*. Melander stated that the brief description was not adequate for identification. Malloch questionably placed it as a synonym of *A. pusilla* Meigen. United States.

Phytomyza dura Curran

Phytomyza dura Curran, 1931, Amer. Mus. Nov., 492:10.

Closely related to *P. lactuca* Frost. Quebec, Canada.

Phytomyza enigma Malloch

Phytomyza enigma Malloch, 1934, Dipt. Patag. S. Chile, 6:485; Ortiz, 1946, Cat. Dipt. Chile, p. 141.

Chile.

Phytomyza flavicornis Fallén

Phytomyza flavicornis Fallén, 1823, Dipt. Suec., Phytomyzid., 2 (41):4; Coquillett, 1900, Proc. Wash. Acad. Sci., 2:464; Melander, 1913, Jour. N. Y. Ent. Soc., 21:270; Frost, 1924, Cornell Mem., 78:74.

The larvae mine in the pith of stems of *Urtica dioica* L. Europe, northern Asia, North America including Alaska.

Phytomyza flavinervis Frost

Phytomyza flavinervis Frost, 1924, Cornell Mem., 78:85.

Texas.

Phytomyza genalis Melander

Phytomyza genalis Melander, 1913, Jour. N. Y. Ent. Soc., 21:272; Frost, 1924, Cornell Mem., 78:85.

Illinois.

Phytomyza genualis Loew

Phytomyza genualis Loew, 1869, Berl. ent. Zeitschr., 13:52; Melander, 1913, Jour. N. Y. Ent. Soc., 21:271; Frost, 1924, Cornell Mem., 78:63.

Melander placed this species as a synonym of *P. albiceps* Meigen. Frost notes that Melander, in manuscript notes, subsequently removed it. Washington, D.C.

Phytomyza hieracii Hendel

Phytomyza hieracii Hendel, 1922, Wien. ent. Zeitung, 39:67; Frost, 1924, Cornell Mem., 78:75; Hendel, 1935, *in* Lindner: Die Flieg. palaearkt. Reg., 59:414.

Frost notes a number of differences between his specimen and one from Europe identified by Hering. Hendel (1935*a*) questionably includes the species from North America. Indiana.

Phytomyza ilicicola Loew

Phytomyza ilicis Loew, 1863 (*nec* Curtis, 1846), Berl. ent. Zeitschr., 7:54. Primary homonym.

Phytomyza ilicicola Loew, 1872 (n.n. for *P. ilicis* Loew, 1863, *nec* Curtis, 1846), Berl. ent. Zeitschr., 16:291; Melander, 1913, Jour. N. Y. Ent. Soc., 21:270; Cameron, 1939, Bull. Ent. Res., 30:173; Underhill, 1943, Virginia Agric. Expt. Sta., 349:27; Hartzell, 1943, Contr. Boyce Thompson Inst., 13:17.

Phytomyza obscurella Weyenberg, 1869 (*nec* Fallén, 1823), Tijdschr. Ent., 12:17.

Phytomyza ilicis Frost, 1924 (*nec* Curtis, 1846), Cornell Mem., 78:76.

P. ilicicola is a native North American species the larvae of which make linear or serpentine mines in the leaves of *Ilex* sp. North America.

Phytomyza ilicis Curtis

Phytomyza ilicis Curtis, 1846, Gdnrs' Chron., July 4, p. 444; Downes, 1931, Proc. Ent. Soc. B.C., 28:25; Hendel, 1935, *in* Lindner: Die Flieg. palaearkt. Reg., 59:417; Cameron, 1939, Bull. Ent. Res., 30:173; Downes and Andison, 1941, Jour. Econ. Ent., 33:948; Downes, 1948, Proc. Ent. Soc. B.C., 44:14.

Phytomyza aquifolii Goureau, 1851, Ann. Soc. Ent. France, (2) 9:143; Frost, 1924, Cornell Mem., 78:66.

Phytomyza ilicis Kaltenbach, 1862 (*nec* Curtis, 1846), Verh. naturh. Ver. preuss. Rheinl. und Westphal., 19:54.

Phytomyza obscurella Haliday, 1837 (*nec* Fallén, 1823), Ent. Mag., 4:147.

This species is native to Europe and has been introduced into western North America. The larvae make blotch mines in the leaves of *Ilex aquifolium* L., an introduced plant. Oregon, Washington, British Columbia.

Phytomyza lactuca Frost

Phytomyza lactuca Frost, 1924, Cornell Mem., 78:85.

The larvae mine the leaves of *Lactuca scariola* L. var. *integrata* Gren. and Godr. Pennsylvania.

Phytomyza loewii Hendel

Phytomyza clematidis Loew, 1863 (*nec* Kaltenbach, 1859), Berl. ent. Zeitschr., 7:55; Melander, 1913, Jour. N. Y. Ent. Soc., 21:269; Frost, 1924, Cornell Mem., 78:71. Primary homonym.

Phytomyza loewii Hendel, 1923 (n.n. for *P. clematidis* Loew, 1863, *nec* Kaltenbach, 1859), Konowia, 2:145.

The larvae mine the leaves of *Clematis* sp. Ontario, Canada, Idaho, Indiana, Washington, D.C.

Phytomyza major Malloch

Phytomyza major Malloch, 1913, Proc. U. S. Nat. Mus., 46:150; Frost, 1924, Cornell Mem., 78:78.

Labrador.

Phytomyza marginalis Frost

Phytomyza marginalis Frost, 1927, Ann. Ent. Soc. Amer., 20:219.

Closely related to *P. atricornis* Meigen. New York.

Phytomyza melanella Frost

Phytomyza melanella Frost, 1924, Cornell Mem., 78:86.

California, Kentucky.

Phytomyza melanogaster Thomson

Phytomyza melanogaster Thomson, 1868, Dipt. Freg. Eugen. Resa, (2) 6 (12):610; Malloch, 1934, Dipt. Patag. S. Chile, 6:485.

Malloch believed the species to be closely related to *P. affinis* Fallén and probably a synonym. Argentina.

Phytomyza minuscula Goureau

Phytomyza minuscula Goureau, 1851, Ann. Soc. Ent. France, (2) 9:153; Frost, 1930, Ann. Ent. Soc. Amer., 23:457; Hendel, 1935, *in* Lindner: Die Flieg. palaearkt. Reg., 59:433.

Phytomyza aquilegiae Robineau-Desvoidy, 1851 (*nec* Hardy, 1849), Rev. Mag. Zool., (2) 3:397 (as *P. ancholiae* Goureau, 1851).

Phytomyza aquilegiae Cory, 1916 (*nec* Hardy, 1849), Jour. Econ. Ent., 9:419; Frost, 1924, Cornell Mem., 78:67.

My specimens were determined by Dr. Hering. This species is widespread in California. The larvae make serpentine mines in the leaves. I have reared the species from *Thalictrum* sp., *Thalictrum fendleri* Engelm., cultivated *Aquilegia* sp., *Aquilegia truncata* F.&M., and *A. pauciflora* Jepson, the last at 9,600 feet elevation in the Sierra Nevada. Widespread in Europe and North America.

Phytomyza minuta Frost

Phytomyza minuta Frost, 1924, Cornell Mem., 78:86.

New Mexico, Texas, North Dakota.

Phytomyza mitis Curran

Phytomyza mitis Curran, 1931, Canad. Ent., 63:97.

Related to *P. minuta* Frost. Reared from cabbage, *Erisimum parviflorum, Radicula palustris,* and *Brassica campestris.* Canada.

Phytomyza nervosa Loew

Phytomyza nervosa Loew, 1869, Berl. ent. Zeitschr., 13:52; Melander, 1913, Jour. N. Y. Ent. Soc., 21:270; Frost, 1924, Cornell Mem., 78:78.

Washington, D.C.

Phytomyza nigra Meigen

Phytomyza nigra Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:191; Melander, 1913, Jour. N. Y. Ent. Soc., 21:270; Frost, 1924, Cornell Mem., 78:78; Hendel, 1935, *in* Lindner: Die Flieg. palaearkt. Reg., 59:437.

Phytomyza lateralis Simm, 1925 (*nec* Fallén, 1823), Bull. Int. Akad. Umiej. B., 1924:735.

Chromatomyia cinereofrons Hardy, 1849, Ann. Mag. Nat. Hist., (2) 4:390.

The larvae mine the leaves of many grasses (Hendel, 1935*b*). Europe, northern Asia, western North America.

Phytomyza nigrinervis Frost

Phytomyza nigrinervis Frost, 1924, Cornell Mem., 78:87.

Colorado.

Phytomyza nigripennis Fallén

Phytomyza nigripennis Fallén, 1823, Dipt. Suec., Phytomyzid., 2 (41):2; Melander, 1913, Jour. N. Y. Ent. Soc., 21:269; Frost, 1924, Cornell Mem., 78:79.

Washington.

Phytomyza nitida Melander

Phytomyza nitida Melander, 1913, Jour. N. Y. Ent. Soc., 21:271; Frost, 1924, Cornell Mem., 78:80.

The larvae mine the leaves of *Nepeta cataria, Ambrosia artemisiifolia, Tanacetum vulgare,* and *Thalictrum polygamum.* Idaho, New York.

Phytomyza obscurella Fallén

Phytomyza obscurella Fallén, 1823, Dipt. Suec., Phytomyzid., 2 (41):4; Coquillett, 1898, Bull. Dept. Agric., Ent., 10:79; Melander, 1913, Jour. N. Y. Ent. Soc., 21:270; Frost, 1924, Cornell Mem., 78:80; Hendel, 1935, *in* Lindner: Die Flieg. palaearkt. Reg., 59:443.

Hendel questionably includes the species from North America. In Europe the species is restricted to the one the larvae of which mine the leaves of *Aegopodium podagraria* L. and *Angelica silvestris* L. Some North American records, such as that from *Lupinus* sp. by Coquillett, are doubtless misidentifications. Europe, Greenland, western North America.

Phytomyza plantaginis Robineau-Desvoidy

Phytomyza plantaginis Robineau-Desvoidy, 1851, Rev. Mag. Zool., (2) 3:404; Frost, 1924, Cornell Mem., 78:82.

Phytomyza robinaldi Goureau, 1851, Ann. Soc. Ent. France, (2) 9:142.

I compared my specimens with European material from Dr. Hering. The larvae are leaf miners on *Plantago* sp. Widespread in Europe and North America.

Phytomyza platensis Brèthes

Phytomyza platensis Brèthes, 1923, Rev. Zool. Agric. et Appl., 22:154; Costa Lima, 1936, Ter. Cat. Insect. Brasil., p. 371.

The larvae mine the leaves of *Salvia splendens*. Argentina, Brazil.

Phytomyza plumiseta Frost

Phytomyza plumiseta Frost, 1924, Cornell Mem., 78:87.

Closely related to *P. albiceps* Meigen. The larvae mine the leaves of *Thalictrum polygamum* and *Aquilegia canadensis*. Pennsylvania, New York.

Phytomyza ranunculi (Schrank) var. flava Fallén

Phytomyza ranunculi (Schrank), 1803, Fauna Bioca, 3 (1):140.

Phytomyza flava Fallén, 1823, Dipt. Suec., Phytomyzid., 2 (41):3; Melander, 1913, Jour. N. Y. Ent. Soc., 21:270; Frost, 1924, Cornell Mem., 78:73.

Phytomyza ranunculi (Schrank) var. *flava* (Fallén): Hendel, 1935, *in* Lindner: Die Flieg. palaearkt. Reg., 59:463.

Phytomyza terminalis Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:195.

Phytomyza pallida Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:196.

Phytomyza citrina von Roser, 1840, Korresp.-Bl. wuertt. landw. Ver., 8:63; Becker, 1903, Jahresb. Ver. Natk. Wuertt., 59:65.

The larvae mine the leaves of *Ranunculus* sp. and *Anemone nemorosa* L. in Europe. Europe, Canada, Washington, Indiana.

Phytomyza ranunculi (Schrank) var. flavoscutellata Fallén

Phytomyza ranunculi (Schrank), 1803, Fauna Bioca, 3 (1):140.

Phytomyza flavoscutellata Fallén, 1823, Dipt. Suec., Phytomyzid., 2 (41):4; Melander, 1913, Jour. N. Y. Ent. Soc., 21:270; Frost, 1924, Cornell Mem., 78:74.

Phytomyza ranunculi (Schrank) var. *flavoscutellata* (Fallén): Hendel, 1935, *in* Lindner: Die Flieg. palaearkt. Reg., 59:465.

The larvae mine the leaves of *Ranunculus* sp. and *Anemone nemorosa* L. in Europe. Europe, Idaho, Oregon.

Phytomyza ranunculi (Schrank) var. praecox Meigen

Phytomyza ranunculi (Schrank), 1803, Fauna Bioca, 3 (1):140.

Phytomyza praecox Meigen, 1830, Syst. Beschr. bekann. eur. zweifl. Insekt., 6:194; Frost, 1924, Cornell Mem., 78:84.

Phytomyza ranunculi (Schrank) var. *praecox* (Meigen): Hendel, 1935, *in* Lindner: Die Flieg. palaearkt. Reg., 59:465.

Phytomyza maculipes Brullé, 1832, Exped. Sci. Morée, 3 (2):321.

Phytomyza maculipes Zetterstedt, 1848, Dipt. Scand., 7:2821.

Phytomyza zetterstedti Schiner, 1864, Fauna Austr., Flieg., 2:315; Lundbeck, 1900, Vid. Medd., 5:307; Melander, 1913, Jour. N. Y. Ent. Soc., 21:270.

The above synonymy is taken from Hendel (1935*c*). The larvae mine the leaves of *Ranunculus* sp. and *Anemone nemorosa* L. in Europe. Europe, Greenland.

Phytomyza subtenella Frost

Phytomyza subtenella Frost, 1924, Cornell Mem., 78:89.

Washington, Wisconsin.

Phytomyza trivittata Frost

Phytomyza trivittata Frost, 1924, Cornell Mem., 78:89.

Nevada.

Phytomyza williamsoni Blanchard

Phytomyza williamsoni Blanchard, 1938, An. Soc. Cient. Argent., 126:358.

The larvae mine the leaves of *Clematis* sp. Argentina.

19. Genus *Ptochomyza* Hering

[Gr., *ptochos*, beggar; plus *myza*]

Ptochomyza Hering, 1942, Zeit. PflKrankheit., 52:530; de Meijere, 1944, Tijdschr. Ent., 86:75.

Type.—Ptochomyza asparagi Hering, 1942, monobasic.

Adult.—Very small, rather slender, not more than 1 mm. in body length. All setae relatively much shortened. Mostly lemon yellow, marked with opaque fuscous; halteres yellow; wings hyaline.

Head: As viewed laterally, subtriangular in form, extending anteriorly dorsad of antennae. Eyes small. Genae elongate ventrally, particularly posteriorly; frontal vitta longer than wide, in dried specimens deeply depressed between genovertical plates, rising abruptly near middle to meet anteriorly projecting lunule. Antennal bases approximate, deeply sunken beneath the overhanging lunule; third segment rounded; arista relatively shortened. Proboscis short. Setae: vi very small, scarcely differentiated from setae of subcranial margin; 4 or 5 ifo; 1 sfo; os sparse, relatively lengthened, nearly as long as shortened fronto-orbital setae, anteriorly directed.

Setal pattern of thorax: 1 h; 1 prs; 2 sa; 0 ia; 1 pa; 3 + 4 or 3 + 5 dc, those anterior to the suture not larger than the acr; 0 prsc; 2 rows of acr, sparse, ending posteriorly between third and fourth dc; 4 sc, subapical, dorsally directed; 1 pp; 1 centrally placed npl; 1 aes; 1 kes.

Wing (fig. 34): Sc a faint fold; C reaching slightly distad of R_{4+5}; veins of R_s very strong, strongly curved forward, R_{4+5} meeting C about three-fourths of distance from base of wing to tip; M_{1+2} scarcely a fold, straight, ending at wing tip; M_{3+4} straight, reaching margin distad of middle of wing; cell Cu partly closed by a fold of Cu; Pl broken immediately before uniting with Cu; Cu + Pl a short fold. Axillary lobe and calypter absent.

Male terminalia: Aedeagal apodeme greatly elongate, extending anteriorly to second abdominal segment and posteriorly to within ninth tergite; epiphallus small, curved; aedeagal hood slender, very elongate, extending distad of anterior margin of ninth tergite. Phallophore greatly elongate anteriorly along aedeagal apodeme, slender; portion bearing phallus very small. Phallus long, very slender; basal section nearly twice as long as median and distal sections combined, slender, an irregular tube, ventral side with undulating margin, no ventral processes; median section short, tubular; distal section composed of a pair of very slender processes. Ninth sternite moderately large, sidepieces broadened, not thickened, smoothly rounded anteriorly; posteriorly very strongly curved dorsally, anterior portion at a level with ventral margin of ninth tergite; arms attaching to bacilliform sclerites short; hypandrial apodeme absent. Pregonites composed of inconspicuous flat plates. Postgonites very large; inner and outer processes united, extending slenderly to phallophore; greatly broadened ventrally, ventral margin irregular; with a strong tooth posteriorly. Ninth tergite articulated to ninth sternite somewhat dorsally; very slightly elongate ventrally, not narrowing. Surstyli not separated by a suture; extending slightly anteriorly, pointed; without conspicuous setae or spines. Bacilliform sclerites separate, uniting at cerci. Cerci small; short, not flattened. Ejaculatory apodeme minute; sclerotized base small; stem short, slender; blade very short, only slightly expanded. Ejaculatory bulb spherical, very large, larger than apodeme; duct attached laterally.

Larva.—(Compiled from de Meijere, 1944.) Small, 1.5 to 2.5 mm. in length; slender, cylindrical, posterior end enlarged. Yellowish.

Head: Mandibles relatively broad, each bearing 2 teeth; not alternating. Labial sclerite moderately short, slender. Paraclypeal phragma with dorsal process very broad, slightly curved; ventral process as long as upper, moderately broad. A lobe on each side of mandibles, bearing small tubercles.

Body: Anterior spiracles colorless; stems elongate, tubular, approximate; spiracular area dark, each with 2 irregular rows of about 9 openings. Abdominal cuticular processes extremely small; bands wider dorsally except on prothorax, where wider ventrally. Posterior spiracles thickened, stems moderately elongate, black; each with 2 rows of bulbs, each having a slitlike opening; acuminate. Posterior end with eighth segment expanded.

De Meijere (1944) tentatively placed the larvae of an unidentified species described from asparagus leaves from Corsica and Brioni (de Meijere, 1937) in this genus. The adults of the southern species have never been found, and the species remains unnamed. A single species, *Ptochomyza asparagi* Hering, is completely known. The larvae mine the leaves of *Asparagus officinalis,* one leaf being sufficient for each larva.

REFERENCE LIST OF NEW WORLD SPECIES WITH PRESENT GENERIC POSITIONS

[All species names in italic type are either homonyms or synonyms.]

Previous Generic Position	Present Generic Position
Agromyza abbreviata Malloch, 1913 (*neo* Fallén, 1823)	Agromyza barberi Frick, new name
Agromyza abnormalis Malloch, 1913	Phytobia (Amauromyza) abnormalis (Malloch), 1913
Agromyza aceris Greene, 1917	Phytobia (Phytobia) aceris (Greene), 1917
Agromyza aeneiventris Fallén, 1823	Melanagromyza aeneiventris (Fallén), 1823
Agromyza affinis Malloch, 1913	Ophiomyia maura (Meigen), 1838
Agromyza albidohalterata Malloch, 1916	Agromyza albidohalterata Malloch, 1916
Agromyza albitarsis Meigen, 1830	Agromyza albitarsis Meigen, 1830
Agromyza allecta Melander, 1913	Phytobia (Calycomyza) allecta (Melander), 1913
Agromyza allia Frost, 1943	Liriomyza allia (Frost), 1943
Agromyza ambigua Fallén, 1823	Agromyza ambigua Fallén, 1823
Agromyza amelanchieris Greene, 1917	Phytobia (Phytobia) amelanchieris (Greene), 1917
Agromyza americana Schiner, 1868	Liriomyza americana (Schiner), 1868
Agromyza andina Malloch, 1934	Liriomyza andina (Malloch), 1934
Agromyza angelicae Frost, 1934	Melanagromyza angelicae (Frost), 1934
Agromyza angolae Malloch, 1934	Melanagromyza angolae (Malloch), 1934
Agromyza angulata Loew, 1869	Phytobia (Poëmyza) atra (Meigen), 1830
Agromyza angulicornis Malloch, 1918	Liriomyza angulicornis (Malloch), 1918
Agromyza anthrax Williston, 1896	Unplaced
Agromyza approximata Frost, 1936	Melanagromyza approximata (Frost), 1936
Agromyza aprilina Malloch, 1915	Agromyza aprilina Malloch, 1915
Agromyza arctica Lundbeck, 1900	Phytobia (Icteromyza) arctica (Lundbeck), 1900
Agromyza aristata Malloch, 1915	Phytagromyza aristata (Malloch), 1915
Agromyza artemisiae Kaltenbach, 1856	Phytobia (Calycomyza) artemisiae (Kaltenbach), 1856
Agromyza assimilis Malloch, 1918	Liriomyza assimilis (Malloch), 1918
Agromyza atra Meigen, 1830	Phytobia (Poëmyza) atra (Meigen), 1830
Agromyza auriceps Melander, 1913	Unplaced
Agromyza baptisiae Frost, 1931	Liriomyza baptisiae (Frost), 1931
Agromyza barrocoloradensis Frost, 1936	Liriomyza barrocoloradensis (Frost), 1936
Agromyza biformata Becker, 1919	Unplaced
Agromyza bipartita Becker, 1919	Unplaced
Agromyza borealis Malloch, 1913	Liriomyza borealis (Malloch), 1913
Agromyza brassicae (Riley), 1884	Liriomyza brassicae (Riley), 1884
Agromyza braziliensis Frost, 1939	Liriomyza braziliensis (Frost), 1939
Agromyza brevicostalis Malloch, 1913	Phytagromyza plagiata (Melander), 1913
Agromyza burgessi Malloch, 1913	Melanagromyza lappae (Loew), 1850
Agromyza buskei Frost, 1936	Melanagromyza buskei (Frost), 1936
Agromyza caerulea Malloch, 1913	Melanagromyza caerulea (Malloch), 1913
Agromyza calyptrata Hendel, 1923	Agromyza calyptrata Hendel, 1923
Agromyza canadensis Malloch, 1913	Agromyza canadensis Malloch, 1913
Agromyza cassiae Frost, 1936	Phytobia (Calycomyza) cassiae (Frost), 1936
Agromyza centrosemae Frost, 1936	Agromyza centrosemae Frost, 1936
Agromyza chilensis Malloch, 1934	Liriomyza chilensis (Malloch), 1934
Agromyza cinereifrons Frost, 1931	Phytobia (Poëmyza) cinereifrons (Frost), 1931

Previous Generic Position	Present Generic Position
Agromyza citreifrons Malloch, 1913	Phytobia (Praspedomyza) clara (Melander), 1913
Agromyza clara Melander, 1913	Phytobia (Praspedomyza) clara (Melander), 1913
Agromyza coloradensis Malloch, 1913	Phytobia (Icteromyza) genualis (Melander), 1913
Agromyza commelinae Frost, 1931	Liriomyza commelinae (Frost), 1931
Agromyza congregata Malloch, 1913	Ophiomyia congregata (Malloch), 1913
Agromyza coniceps Malloch, 1915	Ophiomyia coniceps (Malloch), 1915
Agromyza coquilletti Malloch, 1913	Phytobia (Poëmyza) coquilletti (Malloch), 1913
Agromyza coronata Loew, 1869	Phytobia (Calycomyza) humeralis (von Roser), 1840
Agromyza correntosana Malloch, 1934	Phytobia (? subgenus) correntosana (Malloch), 1934
Agromyza crotonis Frost, 1936	Melanagromyza crotonis (Frost), 1936
Agromyza currani Frost, 1936	Agromyza currani Frost, 1936
Agromyza curvibrissata Frost, 1936	Ophiomyia curvibrissata (Frost), 1936
Agromyza curvipalpis Zetterstedt, 1848	Ophiomyia maura (Meigen), 1838
Agromyza davisii Walton, 1912	Napomyza davisii (Walton), 1912
Agromyza deceptiva Malloch, 1918	Liriomyza deceptiva (Malloch), 1918
Agromyza diadema Melander, 1913	Melanagromyza diadema (Melander), 1913
Agromyza diademata Bigot, 1891	Prosopantrum diademata (Bigot) Edwards (Helomyzidae)
Agromyza diminuta (Walker), 1857	Phytomyza diminuta Walker, 1857
Agromyza discalis Malloch, 1913	Liriomyza discalis (Malloch), 1913
Agromyza diversa Johnson, 1922	Agromyza diversa Johnson, 1922
Agromyza dorsocentralis Frost, 1936	Agromyza dorsocentralis Frost, 1936
Agromyza dubitata Malloch, 1913	Agromyza dubitata Malloch, 1913
Agromyza ecuadorensis Frost, 1939	Liriomyza ecuadorensis (Frost), 1939
Agromyza eupatoriae Malloch, 1915 (*nec* Kaltenbach, 1874)	Melanagromyza mallochi (Hendel), 1923
Agromyza fasiculata Malloch, 1934	Ophiomyia fusciculata (Malloch), 1934
Agromyza felti Malloch, 1914	Liriomyza felti (Malloch), 1914
Agromyza flaveola Fallén, 1823	Liriomyza flaveola (Fallén), 1823
Agromyza flaviventris Johnson, 1902 (*nec* Strobl, 1898)	Liriomyza melampyga (Loew), 1869
Agromyza flavonigra Coquillett, 1902	Liriomyza flavonigra (Coquillett), 1902
Agromyza fragariae Malloch, 1913	Agromyza spiraeae Kaltenbach, 1867
Agromyza fumicosta Malloch, 1914	Liriomyza fumicosta (Malloch), 1914
Agromyza fumosa Hendel, 1923	(? Agromyza) subinfumata Malloch, 1915 (unplaced)
Agromyza gayi Porter, 1915	Liriomyza gayi (Porter), 1915
Agromyza genualis Melander, 1913	Phytobia (Icteromyza) genualis (Melander), 1913
Agromyza gibsoni Malloch, 1915	Melanagromyza gibsoni (Malloch), 1915
Agromyza grossicornis Zetterstedt, 1860	Phytobia (Dizygomyza) luctuosa (Meigen), 1830
Agromyza guaranitica Brèthes, 1920	Unplaced
Agromyza hirticeps Malloch, 1934	Ophiomyia hirticeps (Malloch), 1934
Agromyza holti Malloch, 1924	Liriomyza holti (Malloch), 1924
Agromyza huidobrensis Blanchard, 1926	Liriomyza huidobrensis (Blanchard), 1926
Agromyza humeralis von Roser, 1840	Phytobia (Calycomyza) humeralis (von Roser), 1840

Previous Generic Position	Present Generic Position
Agromyza illinoensis Malloch, 1934	*nomen nudem*
Agromyza immaculata (Coquillett), 1902	Phytoliriomyza perpusilla (Meigen), 1830
Agromyza imperfecta Malloch, 1934	Liriomyza imperfecta (Malloch), 1934
Agromyza inaequalis Malloch, 1914	Agromyza inaequalis Malloch, 1914
Agromyza incisa Meigen, 1830	Phytobia (Poëmyza) incisa (Meigen), 1830
Agromyza inconspicua Malloch, 1913	Phytobia (Poëmyza) inconspicua (Malloch), 1913
Agromyza indecisa Malloch, 1913	Phytobia (? subgenus) indecisa (Malloch), 1913
Agromyza indecora Malloch, 1918	Unplaced
Agromyza infumata Malloch, 1915 (*nec* Czerny and Strobl, 1909)	(? Agromyza) subinfumata Malloch, 1915 (unplaced)
Agromyza innominata Williston, 1896	Not an agromyzid
Agromyza insularis Malloch, 1913	Ophiomyia insularis (Malloch), 1913
Agromyza interfrontalis Melander, 1913	Liriomyza interfrontalis (Melander), 1913
Agromyza invaria Walker, 1857	Unplaced
Agromyza ipomaeae Frost, 1931	Phytobia (Calycomyza) ipomaeae (Frost), 1931
Agromyza iridescens Frost, 1936	Agromyza iridescens Frost, 1936
Agromyza isolata Malloch, 1913	Agromyza isolata Malloch, 1913
Agromyza jucunda van der Wulp, 1867	Phytobia (Calycomyza) jucunda (van der Wulp), 1867
Agromyza kallima Frost, 1936	Phytobia (Phytobia) kallima (Frost), 1936
Agromyza kincaidi Malloch, 1913	Agromyza ambigua Fallén, 1823
Agromyza lacteipennis Fallén, 1823	Meoneura lacteipennis (Fallén), 1823 (Carnidae)
Agromyza lacustris Malloch, 1934	Melanagromyza lacustris (Malloch), 1934
Agromyza lantanae Froggatt, 1919	Ophiomyia lantanae (Froggatt), 1919
Agromyza lappae Loew, 1850	Melanagromyza lappae (Loew), 1850
Agromyza lateralis Williston, 1896 (*nec* Macquart, 1835)	Phytobia (Calycomyza) allecta (Melander), 1913
Agromyza lima Melander, 1913	Liriomyza lima (Melander), 1913
Agromyza longicauda Curran, 1928	Melanagromyza longicauda (Curran), 1928
Agromyza longipennis Loew, 1869	Phytobia (Icteromyza) longipennis (Loew), 1869
Agromyza longiseta Malloch, 1913	Melanagromyza longiseta (Malloch), 1913
Agromyza longispinosa Malloch, 1913	Liriomyza pacifica (Melander), 1913
Agromyza luctuosa Meigen, 1830	Phytobia (Dizygomyza) luctuosa (Meigen), 1830
Agromyza maculosa Malloch, 1913	Phytobia (Amauromyza) maculosa (Malloch), 1913
Agromyza maculosa var. fuscibasis Malloch, 1934	Phytobia (Amauromyza) maculosa var. fuscibasis (Malloch), 1934
Agromyza madizina (Hendel), 1920	Tylomyza madizina (Hendel), 1920
Agromyza magnicornis Loew, 1869	Phytobia (Dizygomyza) magnicornis (Loew), 1869
Agromyza major Strobl, 1900	Ophiomyia major (Strobl), 1900
Agromyza mallochi Hendel, 1923	Melanagromyza mallochi (Hendel), 1923
Agromyza malvae (Burgess), 1880	Phytobia (Calycomyza) jucunda (van der Wulp), 1867
Agromyza marginalis Malloch, 1913	Liriomyza marginalis (Malloch), 1913
Agromyza marellii Brèthes, 1920	Melanagromyza marellii (Brèthes), 1920

Previous Generic Position	Present Generic Position
Agromyza marginata Loew, 1869	Phytobia (Dizygomyza) marginata (Loew), 1869
Agromyza maura Meigen, 1838	Ophiomyia maura (Meigen), 1838
Agromyza melampyga Loew, 1869	Liriomyza melampyga (Loew), 1869
Agromyza melanderi Hendel, 1923	Melanagromyza diadema (Melander), 1913
Agromyza minima Malloch, 1913	Ophiomyia maura (Meigen), 1838
Agromyza meridiana Hendel, 1923	Phytobia (Calycomyza) meridiana (Hendel), 1923
Agromyza meridionalis Malloch, 1914 (*nec* Strobl, 1900)	Phytobia (Calycomyza) meridiana (Hendel), 1923
Agromyza mobilis Meigen, 1830	Agromyza mobilis Meigen, 1830
Agromyza muscina Meigen, 1830	Phytobia (Poëmyza) muscina (Meigen), 1830
Agromyza nasuta Melander, 1913	Tylomyza pinguis (Fallén), 1820
Agromyza neptis Loew, 1869	Agromyza neptis Loew, 1869
Agromyza nigrisquama Malloch, 1916 (*nec* Malloch, 1914)	Agromyza calyptrata Hendel, 1923
Agromyza nitida Malloch, 1913	Agromyza nitida Malloch, 1913
Agromyza nitidiventris Malloch, 1934	Phytobia (? subgenus) nitidiventris (Malloch), 1934
Agromyza oralis Frost, 1936	Ophiomyia oralis (Frost), 1936
Agromyza orbitalis Frost, 1936	Melanagromyza orbitalis (Frost), 1936
Agromyza ornata Meigen, 1830	Liriomyza ornata (Meigen), 1830
Agromyza pacifica Melander, 1913	Liriomyza pacifica (Melander), 1913
Agromyza pagana Malloch, 1934	Liriomyza pagana (Malloch), 1934
Agromyza pallidiseta Malloch, 1924	Unplaced
Agromyza parvicella Coquillett, 1902	Napomyza parvicella (Coquillett), 1902
Agromyza parvicornis Loew, 1869	Agromyza parvicornis Loew, 1869
Agromyza patagonica Malloch, 1934	Liriomyza patagonica (Malloch), 1934
Agromyza perpusilla Meigen, 1830	Phytoliriomyza perpusilla (Meigen), 1830
Agromyza peullae Malloch, 1934	Phytobia (? subgenus) peullae (Malloch), 1934
Agromyza phaseolunata Frost, 1943	Liriomyza phaseolunata (Frost), 1943
Agromyza picta Coquillett, 1902	Liriomyza xanthophora (Schiner), 1868
Agromyza pictella Thomson, 1868	Liriomyza ? flaveola (Fallén), 1823
Agromyza pinguis (Fallén), 1820	Tylomyza pinguis (Fallén), 1820
Agromyza platyptera Thomson, 1868	Phytobia (Calycomyza) ? jucunda (van der Wulp), 1867
Agromyza pleuralis Malloch, 1914	Unplaced
Agromyza plumiseta Malloch, 1913	Melanagromyza lappae (Loew), 1850
Agromyza politella Malloch, 1934	Liriomyza politella (Malloch), 1934
Agromyza pollinosa Melander, 1913	Unplaced
Agromyza posticata Meigen, 1830	Phytobia (Phytobia) posticata (Meigen), 1830
Agromyza proboscidea Strobl, 1900	Ophiomyia proboscidea (Strobl), 1900
Agromyza pruinosa Coquillett, 1902	Phytobia (Phytobia) pruinosa (Coquillett), 1902
Agromyza pruni Grossenbacher, 1915	Phytobia (Phytobia) pruni (Grossenbacher), 1915
Agromyza pseudocunctans Strobl, 1900	Tylomyza pinguis (Fallén), 1820
Agromyza pulicaria Meigen, 1830	Melanagromyza pulicaria (Meigen), 1830
Agromyza punctohalterata Frost, 1936	Ophiomyia punctohalterata (Frost), 1936
Agromyza pusilla Meigen, 1830	Liriomyza pusilla (Meigen), 1830
Agromyza quadrata Malloch, 1934	Liriomyza quadrata (Malloch), 1934
Agromyza quadrisetosa Malloch, 1913	Liriomyza quadrisetosa (Malloch), 1913
Agromyza reptans Fallén, 1823	Agromyza reptans Fallén, 1823

Previous Generic Position	Present Generic Position
Agromyza reverberata Malloch, 1924	Unplaced
Agromyza riparella Hendel, 1923	Melanagromyza riparella (Hendel), 1923
Agromyza riparia Malloch, 1915 (*nec* van der Wulp, 1871)	Melanagromyza riparella (Hendel), 1923
Agromyza rutiliceps Melander, 1913	Unplaced
Agromyza salicis Malloch, 1913	Melanagromyza salicis (Malloch), 1913
Agromyza schineri Giraud, 1861	Melanagromyza schineri (Giraud), 1861
Agromyza schmidti Aldrich, 1929	Liriomyza schmidti (Aldrich), 1929
Agromyza schmidti Frost, 1936 (*nec* Aldrich, 1929)	Agromyza frosti Frick, new name
Agromyza scutellata Fallén, 1823	"Chlorops" scutellatus Panzer, 1809 (Chloropidae)
Agromyza setifrons Melander, 1913	Ophiomyia setifrons (Melander), 1913
Agromyza setosa Loew, 1869	Agromyza setosa Loew, 1869
Agromyza signata Meigen, 1830	Liriomyza ornata (Meigen), 1830
Agromyza similata Malloch, 1918	Melanagromyza similata (Malloch), 1918
Agromyza simplex Loew, 1869	Melanagromyza simplex (Loew), 1869
Agromyza simulator Malloch, 1934	Liriomyza simulator (Malloch), 1934
Agromyza solita Walker, 1857	Unplaced
Agromyza sorosis Williston, 1896	Liriomyza melampyga (Loew), 1869
Agromyza spiraeae Kaltenbach, 1867	Agromyza spiraeae Kaltenbach, 1867
Agromyza subangulata Malloch, 1916	Phytobia (Poëmyza) subangulata (Malloch), 1916
Agromyza subinfumata Malloch, 1915	Unplaced
Agromyza subnigripes Malloch, 1913	Agromyza mobilis Meigen, 1830
Agromyza subpusilla Frost, 1943 (*nec* Malloch, 1914)	Liriomyza subpusilla (Frost), 1943 (primary homonym)
Agromyza subvirens Malloch, 1915	Melanagromyza subvirens (Malloch), 1915
Agromyza sulphuriceps Strobl, 1898	Agromyza sulphuriceps Strobl, 1898
Agromyza superciliosa Zetterstedt, 1860	Phytobia (Poëmyza) muscina (Meigen), 1830
Agromyza taeniola Coquillett, 1904	Phytobia (Phytobia) posticata (Meigen), 1830
Agromyza terebrans Bezzi and Tavares, 1916	Unplaced
Agromyza terminalis Coquillett, 1895	Phytobia (Phytobia) posticata (Meigen), 1830
Agromyza tetrae Malloch, 1934	Melanagromyza tetrae (Malloch), 1934
Agromyza texana Malloch, 1913	Ophiomyia proboscidea (Strobl), 1900
Agromyza tibialis Frost, 1936 (*nec* Fallén, 1823)	Melanagromyza aldrichi Frick, new name
Agromyza tiliae Couden, 1908	Melanagromyza tiliae (Couden), 1908
Agromyza trifolii (Burgess), 1880	Liriomyza trifolii (Burgess), 1880
Agromyza tritici Fitch, 1856	Meoneura sp. (Carnidae)
Agromyza ulmi Frost, 1924	Unplaced
Agromyza varia Melander, 1913	Phytobia (? subgenus) varia (Melander), 1913
Agromyza variata Malloch, 1913	Liriomyza variata (Malloch), 1913
Agromyza varifrons Coquillett, 1902	Agromyza varifrons Coquillett, 1902
Agromyza vibrissata Malloch, 1913	Ophiomyia major (Strobl), 1900
Agromyza virens Loew, 1869	Melanagromyza virens (Loew), 1869
Agromyza virgo Zetterstedt, 1848	Liriomyza virgo (Zetterstedt), 1848
Agromyza viridis Frost, 1931	Melanagromyza viridis (Frost), 1931
Agromyza viridula Coquillett, 1902	Agromyza viridula Coquillett, 1902
Agromyza waltoni Malloch, 1913	Phytobia (Phytobia) waltoni (Malloch), 1913
Agromyza websteri Malloch, 1913	Melanagromyza websteri (Malloch), 1913
Agromyza winnemanae Malloch, 1913	Melanagromyza winnemanae (Malloch), 1913
Agromyza xanthophora Schiner, 1868	Liriomyza xanthophora (Schiner), 1868

Previous Generic Position	Present Generic Position
Agromyza youngi Malloch, 1914	Tylomyza pinguis (Fallén), 1820
Antineura chlamydata Melander, 1913	Haplomyza chlamydata (Melander), 1913
Antineura palliata (Coquillett), 1902	Haplomyza palliata (Coquillett), 1902
Antineura togata Melander, 1913	Haplomyza togata (Melander), 1913
Cerodontha denticornis (Panzer), 1806	Cerodontha denticornis (Panzer), 1806
Cerodontha dorsalis (Loew), 1863	Cerodontha dorsalis (Loew), 1863
Cerodontha flavifrons (Philippi), 1865	Cerodontha flavifrons (Philippi), 1865
Cerodontha fulvithorax Malloch, 1934	Cerodontha fulvithorax Malloch, 1934
Cerodontha nigricornis Becker, 1919	Cerodontha nigricornis Becker, 1919
Dizygomyza jucunda (van der Wulp), 1867	Phytobia (Calycomyza) jucunda (van der Wulp), 1867
Dizygomyza maculosa (Malloch), 1913	Phytobia (Amauromyza) maculosa (Malloch), 1913
Domomyza tamia Melander, 1913	Melanagromyza tamia (Melander), 1913
Limnoagromyza dianthereae Malloch, 1920	Melanagromyza diantherae (Malloch), 1920
Liriomyza angularis Hendel, 1920	Liriomyza angulicornis (Malloch), 1918
Liriomyza cucumifoliae Blanchard, 1938	Liriomyza cucumifoliae Blanchard, 1938
Liriomyza langei Frick, 1951	Liriomyza langei Frick, 1951
Liriomyza sativae Blanchard, 1938	Liriomyza sativae Blanchard, 1938
Liriomyza tubifer Melander, 1913	Liriomyza tubifer Melander, 1913
Napomyza anomala Strobl, 1893	Unplaced
Napomyza lateralis (Fallén), 1823	Napomyza lateralis (Fallén), 1823
Napomyza plagiata Melander, 1913	Phytagromyza plagiata (Melander), 1913
Phytomyza acuticornis Loew, 1858	Pseudonapomyza atra (Meigen), 1830
Phytomyza affinalis Frost, 1924	Phytomyza affinalis Frost, 1924
Phytomyza affinis Fallén, 1823	Phytomyza affinis Fallén, 1823
Phytomyza albiceps Meigen, 1830	Phytomyza albiceps Meigen, 1830
Phytomyza analis Zetterstedt, 1848	Phytomyza analis Zetterstedt, 1848
Phytomyza angelicella Frost, 1927	Phytomyza angelicella Frost, 1927
Phytomyza aquifolii Goureau, 1851	Phytomyza ilicis Curtis, 1846
Phytomyza aquilegiana Frost, 1930	Phytomyza aquilegiana Frost, 1930
Phytomyza atricornis Meigen, 1838	Phytomyza atricornis Meigen, 1838
Phytomyza atripalpis Aldrich, 1929	Phytomyza atripalpis Aldrich, 1929
Phytomyza auricornis Frost, 1927	Phytomyza auricornis Frost, 1927
Phytomyza bicolor Coquillett, 1902	Phytomyza bicolor Coquillett, 1902
Phytomyza centralis Frost, 1936	Phytomyza centralis Frost, 1936
Phytomyza chrysanthemi Kowarz, 1891	Phytomyza atricornis Meigen, 1838
Phytomyza clematidis Loew, 1869 (*nec* Kaltenbach, 1859)	Phytomyza loewii Hendel, 1923
Phytomyza clematovora Coquillett, 1910	Phytomyza clematovora Coquillett, 1910
Phytomyza delphiniae Frost, 1928	Phytomyza delphiniae Frost, 1928
Phytomyza diminuta Walker, 1857	Phytomyza diminuta Walker, 1857
Phytomyza dura Curran, 1931	Phytomyza dura Curran, 1931
Phytomyza enigma Malloch, 1934	Phytomyza enigma Malloch, 1934
Phytomyza flava Fallén, 1823	Phytomyza ranunculi (Schrank) var. flava (Fallén), 1823
Phytomyza flavicornis Fallén, 1823	Phytomyza flavicornis Fallén, 1823
Phytomyza flavinervis Frost, 1924	Phytomyza flavinervis Frost, 1924
Phytomyza flavoscutellata Fallén, 1823	Phytomyza ranunculi (Schrank) var. flavoscutellata (Fallén), 1823
Phytomyza genalis Melander, 1913	Phytomyza genalis Melander, 1913
Phytomyza genualis Loew, 1869	Phytomyza genualis Loew, 1869
Phytomyza hieracii Hendel, 1922	Phytomyza hieracii Hendel, 1922
Phytomyza ilicicola Loew, 1872	Phytomyza ilicicola Loew, 1872

Previous Generic Position	Present Generic Position
Phytomyza ilicis Curtis, 1846	Phytomyza ilicis Curtis, 1846
Phytomyza ilicis Loew, 1863 (*nec* Curtis, 1846)	Phytomyza ilicicola Loew, 1872
Phytomyza lacteipennis Malloch, 1913	Pseudonapomyza lacteipennis (Malloch), 1913
Phytomyza lactuca Frost, 1924	Phytomyza lactuca Frost, 1924
Phytomyza loewii Hendel, 1923	Phytomyza loewii Hendel, 1923
Phytomyza major Malloch, 1913	Phytomyza major Malloch, 1913
Phytomyza marginalis Frost, 1927	Phytomyza marginalis Frost, 1927
Phytomyza melanella Frost, 1924	Phytomyza melanella Frost, 1924
Phytomyza melanogaster Thomson, 1868	Phytomyza melanogaster Thomson, 1868
Phytomyza minuscula Goureau, 1851	Phytomyza minuscula Goureau, 1851
Phytomyza minuta Frost, 1924	Phytomyza minuta Frost, 1924
Phytomyza mitis Curran, 1931	Phytomyza mitis Curran, 1931
Phytomyza nervosa Loew, 1869	Phytomyza nervosa Loew, 1869
Phytomyza nigra Meigen, 1830	Phytomyza nigra Meigen, 1830
Phytomyza nigrinervis Frost, 1924	Phytomyza nigrinervis Frost, 1924
Phytomyza nigripennis Fallén, 1823	Phytomyza nigripennis Fallén, 1823
Phytomyza nitida Melander, 1913	Phytomyza nitida Melander, 1913
Phytomyza nitidula Malloch, 1913	Pseudonapomyza atra (Meigen), 1830
Phytomyza obscurella Fallén, 1823	Phytomyza obscurella Fallén, 1823
Phytomyza orbitalis Melander, 1913	Phytagromyza orbitalis (Melander), 1913
Phytomyza palliata Coquillett, 1902	Haplomyza palliata (Coquillett), 1902
Phytomyza plantaginis Robineau-Desvoidy, 1851	Phytomyza plantaginis Robineau-Desvoidy, 1851
Phytomyza platensis Brèthes, 1920	Phytomyza platensis Brèthes, 1920
Phytomyza plumiseta Frost, 1924	Phytomyza plumiseta Frost, 1924
Phytomyza praecox Meigen, 1830	Phytomyza ranunculi (Schrank) var. praecox (Meigen), 1830
Phytomyza solita Walker, 1857	Phytomyza ? affinis Fallén, 1823
Phytomyza subtenella Frost, 1924	Phytomyza subtenella Frost, 1924
Phytomyza trivittata Frost, 1924	Phytomyza trivittata Frost, 1924
Phytomyza williamsoni Blanchard, 1938	Phytomyza williamsoni Blanchard, 1938
Phytomyza zetterstedti Schiner, 1864	Phytomyza ranunculi (Schrank) var. praecox (Meigen), 1830
Triticomyza cruciata Blanchard, 1938	Cerodontha cruciata (Blanchard), 1938

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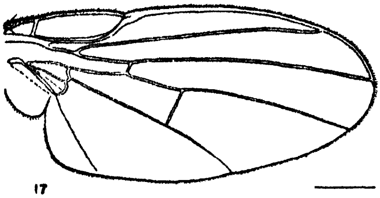
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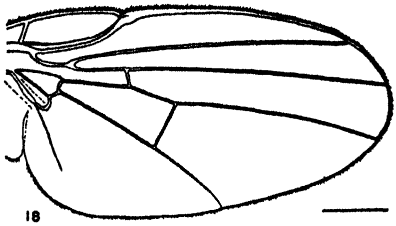
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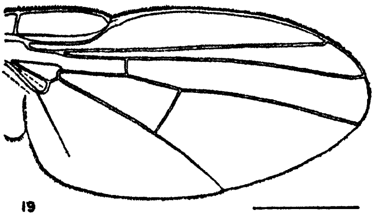
Fig. 17. Wing of *Agromyza ambigua* Fallén, 1823. Solid line, 0.5 mm.
Fig. 18. Wing of *Melanagromyza aeneiventris* (Fallén), 1823. Solid line, 0.5 mm.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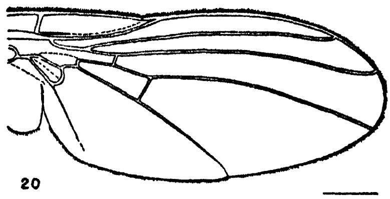
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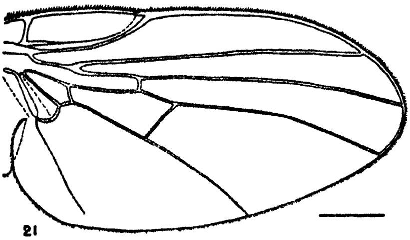
Fig. 19. Wing of *Tylomyza pinguis* (Fallén), 1820. Solid line, 0.5 mm.
Fig. 20. Wing of *Selachops flavocincta* Wahlberg, 1844. Solid line, 0.5 mm.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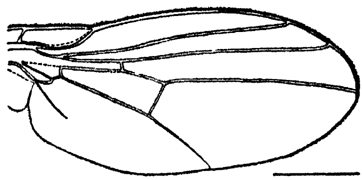
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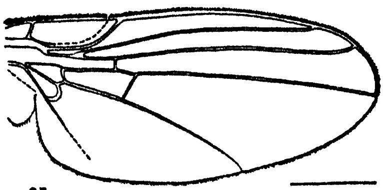
Fig. 21. Wing of *Phytobia errans* (Meigen), 1830. Solid line, 0.5 mm.
Fig. 22. Wing of *Cerodontha denticornis* (Panzer), 1806. Solid line, 0.5 mm.



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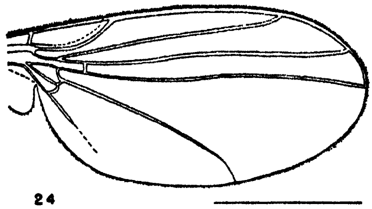

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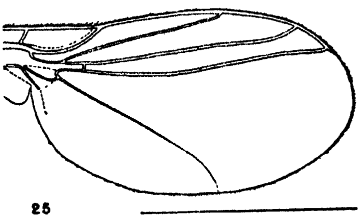
Fig. 23. Wing of *Liriomyza urophorina* Mik, 1894. Solid line, 0.5 mm.
Fig. 24. Wing of *Metopomyza xanthaspis* (Loew), 1858. Solid line, 0.5 mm.



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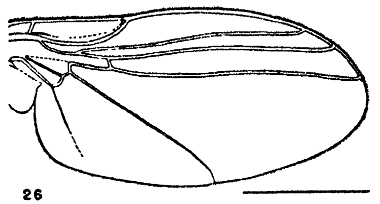

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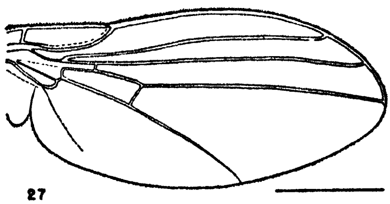
Fig. 25. Wing of *Xeniomyza ilicitensis* de Meijere, 1934. Solid line, 0.5 mm.
Fig. 26. Wing of *Haplomyza togata* (Melander), 1913. Solid line, 0.5 mm.



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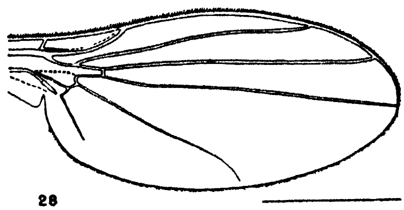

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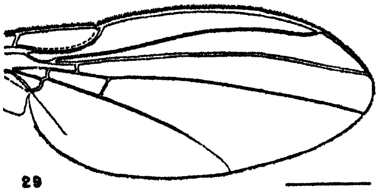
Fig. 27. Wing of *Phytoliriomyza perpusilla* (Meigen), 1830. Solid line, 0.5 mm.
Fig. 28. Wing of *Xyraeomyia conjunctimontis* n. sp., allotype female. Solid line, 0.5 mm.



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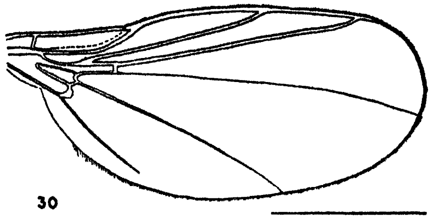

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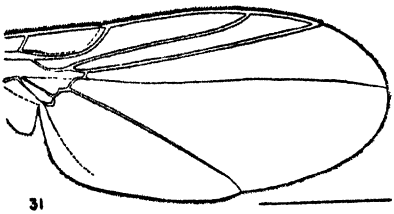
Fig. 29. Wing of *Phytagromyza flavocingulata* (Strobl), 1909. Solid line, 0.5 mm.
Fig. 30. Wing of *Gymnophytomyza heteroneura* (Hendel), 1920. Solid line, 0.5 mm.



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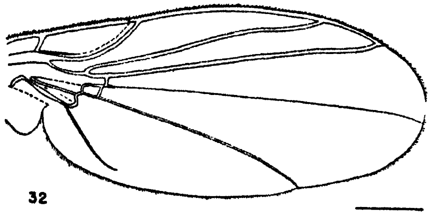

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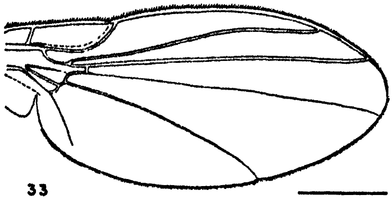
Fig. 31. Wing of *Pseudonapomyza atra* (Meigen), 1830. Solid line, 0.5 mm.
Fig. 32. Wing of *Napomyza lateralis* (Fallén), 1823. Solid line, 0.5 mm.



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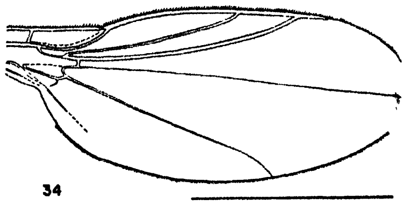

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Fig. 33. Wing of *Phytomyza obscurella* Fallén, 1823. Solid line, 0.5 mm.
Fig. 34. Wing of *Ptochomyza asparagi* Hering, 1942. Solid line, 0.5 mm.